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CITY COUNTY STATE

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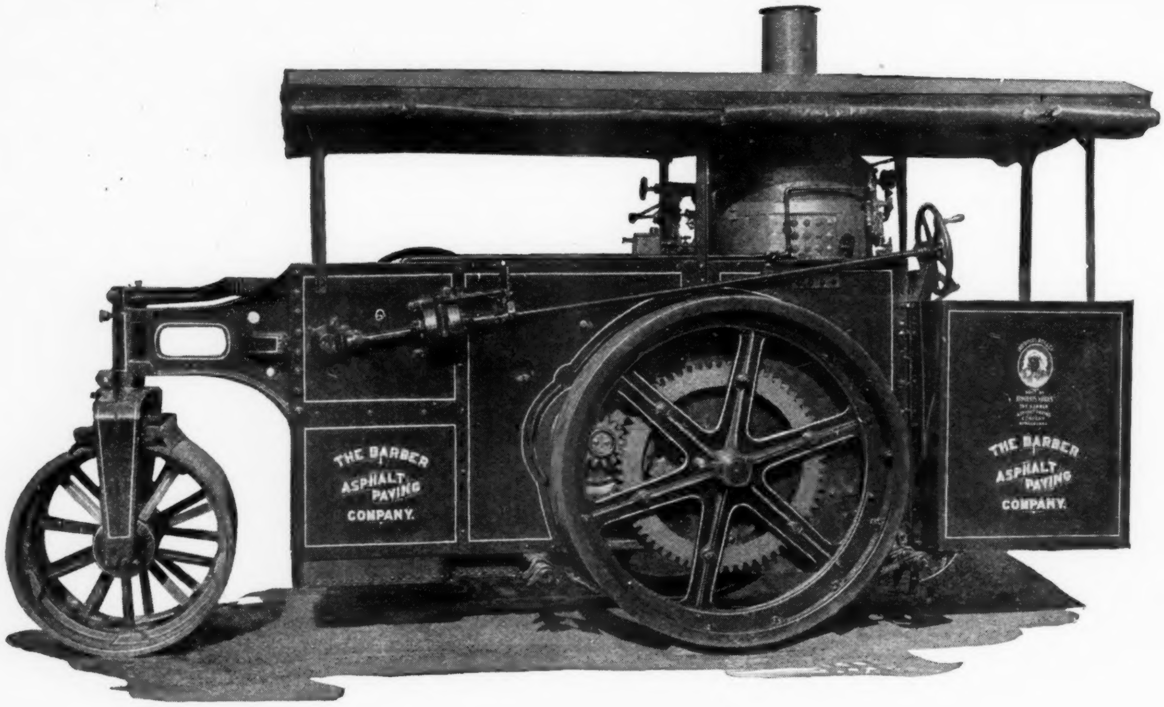

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PUBLIC WORKS.

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Vol. 48 NEW YORK, FEBRUARY 7, 1920 No. 4

Resurfacing Old Pavements

Resurfacing of pavements is the most important and difficult of the problems before the highway officials of the larger and older cities, and is rapidly becoming so for the others as well. With this article we begin a series dealing with this subject, this being a general review, briefly touching upon all of the standard kinds of pavement.

A total of $435,000 spent for new construction; but $1,437,000 for maintenance and reconstruction.

The above figures, from the 1919 annual report of the Connecticut Highway Department, are significant and interesting, not because they are peculiar to that state, but rather because they are typical of all the states and cities where paving has been going on for ten years or more.

When a city or a state begins a paving program, the people and frequently the officials themselves are apt to so concentrate their thoughts and efforts upon *construction* as to overlook the fact that the pavements they are constructing, no matter how good the material or workmanship, will some time wear out and need repairing and replacing.

WHEN RESURFACING IS NECESSARY.

The length of the period before resurfacing or reconstruction becomes necessary varies, of course, with the kind of pavement and nature of traffic. A hard-surface pavement on a concrete base will ordinarily last longer, even under heavy traffic, than a gravel or plain macadam road under ordinary present-day traffic. The time when repairing or resurfacing is undertaken also varies more

RESURFACING SHEET ASPHALT ON FIFTH AVENUE, NEW YORK.

REMOVING SHEET ASPHALT SURFACE WITHOUT STOPPING TRAFFIC, SAN FRANCISCO.

or less with the class of surface material employed. For instance, sheet asphalt, bituminous concrete or similar pavements constructed of aggregates bound with bitumen or water can be patched and repaired when slight inequalities have been caused by wear. A block pavement, however, such as clay block or brick, stone block, or wood block, cannot be patched so readily and if constructed of uniform material ordinarily will not need attention so soon, and repairs to such pavements are generally deferred for a much longer time.

Most cities except the newest have already found some of their streets reaching the point where something must be done to put them into reasonably good condition. If a good concrete base was used, it will not generally be necessary to disturb this, but the old surface can be removed and replaced with a new one of the same or a different kind. Or if the pavement is one composed of aggregates, it may not be necessary to remove all of the old surfacing material. Another method of treatment is to use the old pavement, surface and all, as a base for a new wearing material, which new surface is usually a sheet asphalt or bituminous macadam.

Of the several hundred cities reporting to "PUBLIC WORKS" the kind and amount of paving work done during 1919, a considerable majority report having resurfaced some of their streets. In many of the older cities practically all of the paving was resurfacing, if we include in resurfacing all paving which does not disturb the original base. As the older and larger cities have now paved practically all of their streets, using a concrete base under most of the pavements, practically the entire paving work in such cities in the future will be resurfacing, except for the small amount of new paving on street extensions and in newly opened-up districts which may develop from year to year.

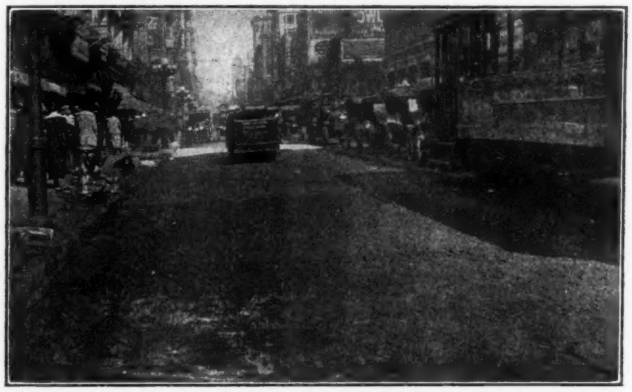
A reference to the table in this issue will show many interesting cases of resurfacing and will give a good general idea of the more prevalent methods of performing such work. We will give in the following paragraphs a summary of some of the more salient features of the information submitted and also describe at length some of the methods employed.

RESURFACING MACADAM.

The kind of pavement appearing most commonly in the reports of resurfacing is naturally water-bound macadam, both because this pavement is in more common use than any other and also because it is being worn out more rapidly by auto truck traffic than almost any other. In many cases, of course, the entire pavement is being taken up and replaced with another pavement having a concrete base. An increasing number of paving engineers, however, are coming to the conclusion that a macadam pavement which has been down for a number of years has become so thoroughly compacted, together with the subsoil under it, that it furnishes as substantial a support as would a new concrete base.

The most common method of resurfacing macadam is by the use of bituminous concrete, although there are numerous instances of the use of sheet asphalt, brick, and most of the other kinds of surfacing materials.

Preparing the Old Surface—Macadam which has been worn so far as to need resurfacing generally contains a number of pot-holes and less serious depressions, and sometimes there has been a general removal of the entire centre of the roadway by wear. This condition of non-uniform surface is found in other pavements as well, and in all such cases the general principle should be adopted of bringing the old pavement, which is to be used as a base, to a uniform surface before applying the wearing course. This is, of course, imperative where a brick or other block pavement is to be laid, but it is almost equally necessary where sheet asphalt or other



ROLLING NEW SHEET ASPHALT SURFACE. SAN FRANCISCO.

bituminous material is to be used. The reason for this is that all bituminous surface compacts more or less under traffic, and the extent of this compacting varies with the thickness of the material. Consequently, if the pot-holes were filled with the bituminous surface material, such material at these points would compact more than where the thickness was less, and depressions would form over the original pot-holes. For this reason it is desirable that all such holes and depressions be filled with a material just as stable and incompressible as the balance of the old pavement; also, that the old pavement be so treated with this material as to produce a surface parallel to the proposed surface of the new wearing course, giving a uniform thickness to such course.

For surfacing the old pavement two general methods are employed, one being to leave all of the old material and fill up the depressions with new; the other being to loosen up the top two or three inches of the old macadam by scarifying, bring the loosened material to the desired grade and surface, and compact thoroughly by rolling. Where the grade of the old pavement is not such as to permit placing the new wearing material upon it without bringing the grade of the street too high, it becomes necessary not only to scarify the macadam, but also to remove some of it, in which case the scarifying must ordinarily be carried deeper in order that a little loose material may be left after

removing that necessary for the lowering of the grade.

There is the objection to scarifying that it results in a top course of the old pavement which has been disturbed from its original compacted condition and therefore, no matter how thoroughly rolled, will be subject to a slight future settlement. For this reason it would seem desirable, where it is not necessary to remove some of the macadam, to leave this undisturbed and to fill in the depressions with a material equally incompressible.

Leveling Up—The material used for leveling up macadam is perhaps most frequently bituminous concrete, although cement concrete could be used for the same purpose. In view of the fact that, no matter how thoroughly rammed or even rolled the patches of bituminous concrete may be, they are still subject to more or less settling, while cement concrete when once set will not settle, the writer would prefer the use of the latter material in cases where an old macadam is used without disturbing the surface.

No matter what material is used for leveling up, all dust and loose material should be swept from the depressions and it is perhaps desirable even to wash them out, but without using jets of water having sufficient velocity to disturb the compacted material. The new material should bond firmly with the old pavement, and it cannot do this if there be dust between them.

Where the resurfacing is to be merely a surface treatment, such as covering with oil and a sprinkling of sand or screenings, more care must be taken with the patches. The method employed in Wellington, N. J., as reported by Borough Engineer Anton L. Pettersen, illustrates the best practise. His description is as follows:

"Those parts of the pavements where holes appeared were cleaned and all loose stone and dirt removed. The sides were then cut vertical and the holes filled with broken stone of sizes from 2½ to one inch, which were thoroughly tamped until solid. This new stone was then painted with a light coat of Tarvia K P, using from one-quarter to one-half gallon per yard. On top of this was placed another mixture consisting of one part sand to three parts of ¾-inch stone, together with Tarvia K P, enough of this being used to level up the hole or depression after it had been tamped thoroughly with a heavy iron tamper. When the added material had been thoroughly tamped and made level with the rest of the pavement, a light seal-coat of Tarvia K P was applied and covered with screenings. Great care must be taken to see that not too much Tarvia is used; it is preferable to use too little rather than too much."

Cement concrete is used in Rochester, N. Y., for filling all but minor inequalities in the surfacing. The proper crown is obtained by removing the necessary amount of old macadam, and any depressions remaining in the newly graded surface are filled with 1:2½:5 concrete.

A typical instance of entirely redressing the old macadam by scarifying is offered by Norristown, Pa., where Borough Engineer S. Cameron Corson employs the following method: The old macadam is scarified deep and all excess dirt is removed by forking over the loosened macadam, the stone so cleaned of fine material being used again. After the scarified stone has been removed, crushed slag is spread over the remaining macadam and rolled, and the old macadam stone, free from dirt, is spread over this and the whole is rolled. This pavement was surfaced with Tarvia macadam.

In some cases where the surface needs quite a little shaping, a scraper is used for bringing the loosened macadam to the proper grade and surface. In all cases where the road has been scarified, it is especially desirable to roll it thoroughly with a heavy roller so as to compact it as completely as possible.

Old Concrete Base Resurfaced for a New Sheet Asphalt Top.

REMOVING AND CLEANING BRICKS BY MEANS OF COMPRESSED AIR. TROY, N. Y.

MACADAM REINFORCED WITH BRICK. LINCOLN HIGHWAY, ILLINOIS.

Where macadam so resurfaced is used as a base for sheet asphalt, a binder may be placed upon the macadam, or in some cases the macadam is painted and the asphalt wearing surface applied directly to it. Where brick or other block is laid, either a sand cushion or a sand-cement mortar course is spread upon the surfaced macadam.

PREPARING CONCRETE BASE.

In using an old concrete base where this was originally well constructed, it is ordinarily necessary only to remove the sand cushion or other material in immediate contact with the base. If asphaltic material is to be placed directly upon the base, it is generally desirable to clean this thoroughly so as to enable the new material to adhere to it. If the new wearing course is of less thickness than the old (as in the case of replacing stone block with brick, or either of these with sheet asphalt), concrete of the desired thickness should be spread over the old base, the surface of the latter being not only swept but also thoroughly washed by hose and left saturated with water when the new concrete is applied. All depressions or bad spots in the concrete should be filled with new concrete. Wherever new concrete is added to the old, the old concrete should be thoroughly wet and preferably given a thin coat of cement mortar before adding the new material.

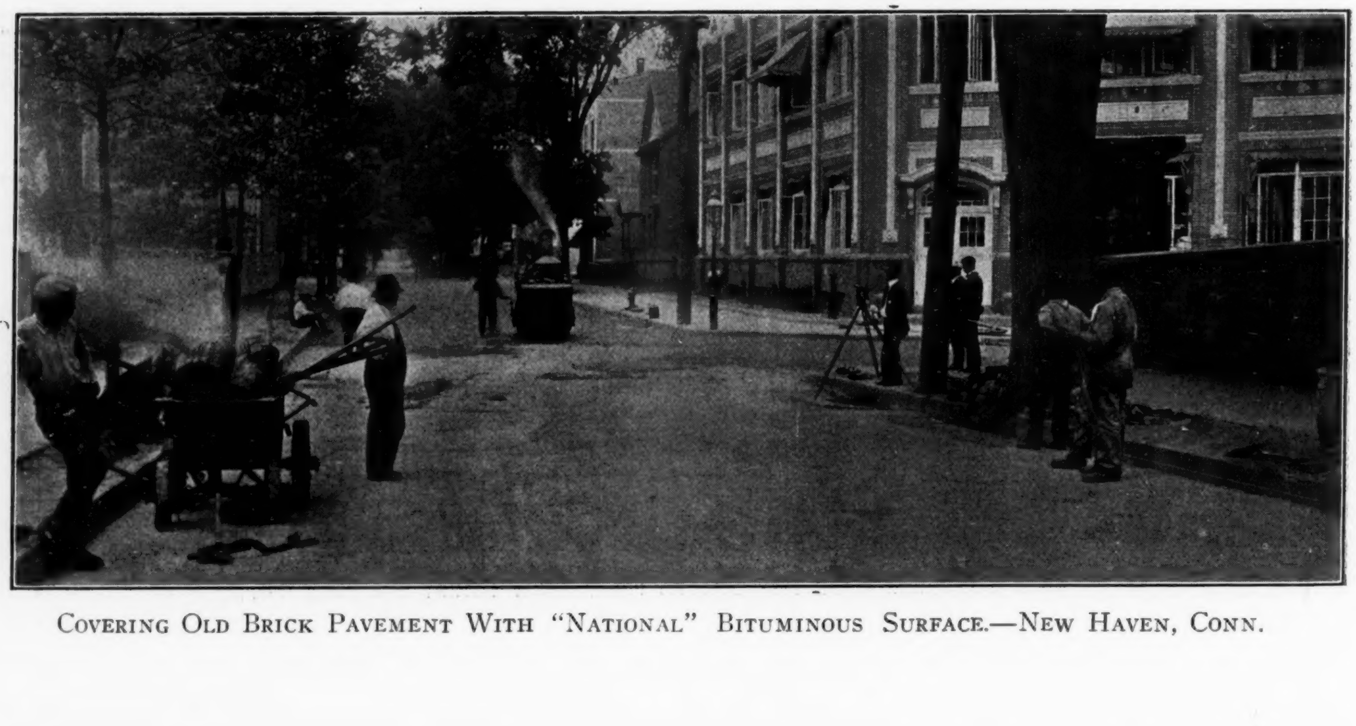
COVERING BRICK OR BLOCKS.

A practise which is coming into more general use is that of placing a wearing surface of sheet asphalt or bituminous concrete on an old brick or stone block pavement without removing the old wearing material. This is practicable only when the old material has worn down to a depth below the established grade of the street equal to the thickness desired for the new wearing surface, or where it is possible to raise the street grade an inch or two. In this work, the old block surface is treated in the same way as the concrete base —it is thoroughly cleaned of all dirt and loose material and all depressions having a depth of one inch or more are filled with cement concrete to bring them up to the general level of the old pavement. In one city at least, where the brick pavement had been laid with a sand filler, the filler was raked out to a depth of two or three inches from all of the joints and these joints filled with cement grout.

Several cities in the Middle West still have brick pavements laid twenty years or more ago by the so-called two-course method, the base consisting of a layer of brick, generally laid on the flat side. Several of these have been resurfaced during the past year by taking up the wearing surface of brick and leaving in the base course of brick, this latter being leveled up where necessary by the use of cement concrete and used as a base for a new brick surface.

RE-USE OF BRICK AND BLOCK.

Several cities report resurfacing old brick pavements by using the old bricks over again, the bricks being removed and culled, the base put in condition and the old brick relaid, what was the bottom of the brick being



COVERING OLD BRICK PAVEMENT WITH "NATIONAL" BITUMINOUS SURFACE.—NEW HAVEN, CONN.

now placed on the top. The old bricks should be used continuously so far as they will go, and the new brick employed to make up any deficiency occasioned by the rejecting of culls should all be concentrated in one point.

The practise has become quite common of relaying stone block pavements by taking up the blocks, breaking them in two and forming a new face to be used for the top surface. Several instances of this have been described at some length in "Municipal Journal" during the past two or three years.

RESURFACING SHEET ASPHALT.

In resurfacing sheet asphalt, the more common method is to entirely remove the old asphalt by prying it up from the concrete base, and relay a new wearing surface in exactly the same way as in new construction. Quite a considerable amount of resurfacing has been done recently, however, by removing only the top half-inch or so of the old sheet asphalt. This has been done to the extent of thousands of square yards in Brooklyn and Manhattan Boroughs, New York, during the past year. A detailed description of this work will be published within the next two or three weeks. In general, it may be said that the old sheet asphalt is heated by a hot air blast, thus softening it so that it can be removed by means of a hoe. The top surface is so removed to the depth of about a half inch, and while the asphalt surface is still warm, a new asphalt surface mixture is spread and rolled, a sufficient thickness of new material being used to give a finished depth of about one inch. This resurfacing in Brooklyn last year cost an average of $1.75 per square yard, whereas a new pavement on a six-inch concrete base cost $4.01 per square yard. The same treatment was employed in Manhattan Borough for resurfacing asphalt block.

A few cities report resurfacing old wood block pavement, the old block being removed and a new block of the same or some other material laid in place of it.

The above is merely a brief outline of what is coming to be the most important duty of municipal paving departments—the keeping of paved streets in good condition. As already stated, most progressive cities have already paved a large percentage of the streets already opened and lying within their boundaries, and new paving for the future will be confined to a considerable extent to newly opened streets and to those existing in areas annexed from time to time to the city. We expect to publish during the year 1920 a considerable amount of information valuable for paving engineers and superintendents, concerning this important subject of maintaining and resurfacing pavements.

Annual Paving Statistics

Facts and figures from several hundred cities concerning the amount and nature of work done by each during 1919, the cost of each class of pavement, whether laid by contract or by municipal forces, and specially complete data concerning resurfacing—the age of pavement, nature of traffic it had carried, materials and methods employed in resurfacing, etc.

It has been our practice for many years past to give, in February of each year, figures and other data relative to the paving done during the previous year by cities throughout the country. This issue is our "Annual Paving Number," and we are confident that readers will find it unusually rich in valuable information. The data have been furnished by city engineers and other officials in charge of paving in response to questionnaires sent by us, and are official and up-to-date.

So voluminous is the matter received, that only a part of it can be given in one issue. Consequently data have been tabulated only from those cities whose replies were in hand several days ago. Information from several hundred other cities will be given in later issues.

Ten of the twelve tables refer to the amounts and costs of specified kinds of pavements, one to the resurfacing of old pavements, and the twelfth to labor conditions in the several cities, and whether pavements were laid by city forces or by contract. In all of the information, the pavements referred to are those within the city limits.

Quantities are given in either square yards or miles—the size of the figure clearly shows which unit is referred to. Cost is per square yard, and includes base but not grading or other features of street improvements, unless otherwise designated. Where the base is not included in the cost, informants were asked to give the cost of the base.

In Table No. 7, the question was asked: "Did the pavement carry residence or business traffic?" Where the answer "Both" is given, it refers to these two classes of traffic.

The first column in Table No. 12 is in answer to the question: "By what percentage was the cost of the different kinds of pavement higher in 1919 than before the war?" The second column, to the question: "About how many unskilled laborers will be available for contract work in 1920, in the city and vicinity.

It is believed that the headings to the other columns are sufficiently explanatory to need no amplification.

In addition to supplementary tables, summaries of the information given in them will be published at intervals.

TABLE NO. 1—SHEET ASPHALT LAID IN CITY STREETS DURING 1919.

City and State.	Yards or miles laid	Average cost per sq. yd.	Base: Kind	Base: Thick-ness inches	Base: Cost	Surface Thick-ness inches	Binder Thick-ness inches
Connecticut							
New Haven	53,545	$1.70m	1:3:6 Concrete*	6	$0.77	1½	1½
Florida							
Tampa	3,000	2.00n	Shell	5	....	1½	...
Illinois							
East St. Louis	3,158	1.85mn	Concrete on old base	4½	8.45†	2	1
La Grange	13,000	2.53	Concrete on old macadam	4	....	1½	1½
Peoria	5,000	1.75mn	Old trick	..	....	1½	1
Indiana							
Elkhart	3	2.87n	Concrete	6	....	1½	1
Fort Wayne	82,410	2.10n	1:2:4 Concrete	..	....	1½	1
Marion	6,263	2.70m	Old concrete	6	....	2	1
South Bend	63,551	2.97	Concrete	5	....	1½	1½
Iowa							
Creston	20,900	3.37	Concrete	4	....	1½	1
Emmetsburg	73,000	2.75n	Concrete	4 & 5	....	...	...
Kentucky							
Louisville	38,048	3.90	Concrete	6	....	1½	1½
Massachusetts							
Brockton	8,548	1.85m	....	..	....	...	2
Springfield	39,000	1.75	Old macadam	..	....	1	1½
Michigan							
Flint	130,000	4.00	Concrete	6	....	...	1
Lansing	58,000	3.05	Concrete	6	....	...	...
Midland	13,133	1.79mn	Old macadam	..	....	1½	1
Midland	6,188	2.945n	Concrete	6	....	1½	1
Missouri							
Kansas City	85,278	3.88	Concrete	5	....	1½	1½
Nebraska							
Lincoln	5,075	...	Concrete	..	....	2½	1½
New Jersey							
Camden	18,000	3.80	....	..	....	2½	1½
Jersey City	50,016	2.15	Concrete	5	....	2	1½
New Brunswick ..	45,350	3.10n	1:3:6 Concrete	..	....	2	...
Passaic	16,550	3.25n	Concrete	6	....	3	6
Jersey City	36,335	1.98n	Old stone block	..	....	2	1½
New York							
Albany	5,839	3.17n	Concrete	6	....	2	1
Brooklyn	14,760	4.01	Concrete	6	....	2	1
Rochester	105,990	1.60mn	1:2½:5 Concrete	6	....	2	1
North Carolina							
Fayetteville	21,000	3.18	Concrete	5	....	1½	1½
Statesville	15,000	1.30mn	1:3:6: Concrete	5	....	...	...
Ohio							
Columbus	17,159	3.50n	Concrete	6	....	2	1
Fremont	4,420	4.15	Concrete	6	....	1½	1½
Lima	12,187	3.12n	Concrete	6	....	2	1
Toledo	11,927	3.40n	Concrete	6	....	1½	1½
Oklahoma							
Oklahoma City ...	50,388	2.40n	Concrete	4	....	...	...
Pennsylvania							
Erie	120,764	2.38	Concrete	5	1.07	1½	1½
Philadelphia	103,574	2.865	Concrete	6	....	1½	1
Pittsburg	1,830	3.42n	....	6	....	1½	1½
Reading	{14,664	3.63	Concrete	6	....	1½	1½
		3.18	Concrete	4	....	1½	1½
Scranton	4,352	2.68	Concrete	6	....	2	2
Tennessee							
Jackson	18,000	2.67	1:3:6 Concrete	5	....	1½	1½
Texas							
San Antonio	46,000	1.25mn	Gravel	6	0.75	2	...
San Antonio	4,420	0.54mn	Gravel	6	0.75	1	...
Utah							
Ogden	42,685	2.58n	Concrete	6	....	1½	1½
Virginia							
Covington	43,956	2.15	Concrete	5	....	1½	1½

TABLE NO. 2—BRICK PAVEMENT LAID DURING 1919 (Continued).

Ohio							
Akron	1.40	3.90	Concrete	6	...	1	Cement
Ashland	10,990	3.84	Concrete	5	1.50	1½	Tar or sand
Columbus	20,127	3.55n	Concrete	6	...	...	Grout
Conneaut	1,573	3.65n	Concrete	5	...	...	Cement
Coshocton	20,000	3.00	Gravel	8	...	1	Tar
East Palestine ..	11,000	2.75n	Furnace slag	6	...	1	Sand
Fremont	3,800	3.31n	Concrete	4	...	1	Sand
Lakewood	7,120	3.60n	Concrete	4	...	...	Cement
Lancaster	2,800	2.07n	Rolled gravel	6	...	1½	Asphalt
Niles	17,000	2.25n	Slag	6	0.75	2	Grout
Sidney	47,215	3.13	Concrete	6	1.00	2	Cement
Toledo	5,141	3.62n	Concrete	6	...	1	Mostic
Zanesville	19,800	3.55n	Concrete	6	...	1½	Asphalt
Oklahoma							
Oklahoma City ..	662	3.35n	Concrete	4	...	1	...
Bartlesville	14,000	2.23mn	{Concrete}	5	...		...
			{Cinders}	6	...	1½	...
Pennsylvania							
Altoona	1,392	3.80m	1:3:6 Concrete	5	...	...	...
Archibald	9,000	3.53	Concrete	6	...	1½	Cement
Carlisle	3,550	1.06	Concrete	4	...	...	...
Clearfield	3,600	2.50	Concrete	6	...	2	Tar
Greensburg	2,354	3.03	Slag	7	...	1	Cement
New Castle	0.50	3.85	......	6	...	...	...
North Braddock .	701	4.70	Concrete	6	...	1	Sand
Philadelphia	8,327	4,163	Concrete	6	...	½	Cement
Pittsburgh	48,372	3.55n	....	6	...	...	...
Rankin	3,500	3.65††	Concrete	6	...	1	Grout
Reading	2,240	4.99	Concrete	4	...	¾	Grout
Williamsport ...	3,896	3.71	Concrete	6	...	...	...
Windber	5,089	3.85	Concrete	6	...	1½	Carey
Texas							
Dallas	2,503	3.25	......	6	...	½	Asphalt
Virginia							
Covington	720	3.10	Concrete	4	...	...	...
Covington	719	4.50	Concrete	4	...	...	...
West Virginia							
Grafton	1,114	....	Concrete	...	...	...	...
Wisconsin							
Grand Rapids ...	4,800	2,785n	Concrete	5	...	1½	Asphalt
Kenosha	63,519	3.00†‡	Concrete	5	...	1½	Asphalt
Madison	8,256	1.85mn	1:3:5 Concrete	6	1.10	1	Cement
Portage	10,000	1.50	Sand	...	...	...	...
Racine	50,000	3.16	Concrete	5	...	2	Asphalt

n Does not include grading or other work. m Does not include base.
†Between and 20 inches outside of trolley tracks.
*Does not include sand for cushion and grout. ‡Does not include gravel and sand.
††Includes all work except grading.
‡‡Exclusive of grading, curb, and gutter.

TABLE NO. 3—GRANITE OR OTHER STONE BLOCK LAID IN CITY STREETS DURING 1919.

City and State	Yards or miles laid	Average cost per sq. yd.	Base: Kind	Base: Thick-ness inches	Base: Cost	Kind of filler
Kentucky						
Louisville	12,902*	$2.74	Concrete	6	....	Portland Cement
Massachusetts						
Brockton	14,314†	2.20m	Sand	..	....	Cement
Lowell	0.1021	...	Sand	..	....	Cement grout
Lowell	0.2699	...	Concrete	5	....	Cement grout
			{Hassam	1	....	....
New Bedford	16,915	6.50	{Sand Cushion	1½		Cement
Peabody	2,952‡	4.12	{Cement	4	....	1:1 Cement
			{Sand	2	$1.65	grout
Springfield	10,000*	6.25	Concrete	5	....	Cement
Watertown	10,102	5.42n	Concrete	6	....	1 in. sand
Missouri						
Kansas City	26,037	7.86	Concrete	10	....	....

Wisconsin							
Beloit	37,000	2.07n	Concrete	5	....	1½	1
Kenosha	23,661	2.50	Concrete	5	....	1½	1
Madison	11,084	1.85mn	1:3:5 Concrete	6	1.10	2	1
Madison	7,327	1.72mn	1:3:5 Concrete	5	1.00	1½	1
Racine	35,000	2.75	Concrete	5	....	2	1
Canada							
Charlottetown,	10,000	1.39mn	....	6	1.50	...	2

*Old macadam except 800 yards. †Cost per cubic yard. m Does not include base. n Does not include grading or other work.

TABLE NO. 2—BRICK PAVEMENT LAID IN CITY STREETS DURING 1919.

City and State.	Yards or miles laid.	Average cost per yard.	Base—Kind.	Base—Thickness, inches.	Base—Cost.	Depth of cushion, inches.	Kind of filler.
Alabama							
Selma	5,600	$2.01n	Concrete	2	...	2	Cement
Connecticut							
New Haven	5,702	4.00mn	Old concrete	...	...	1½ in. mortar	Grout
Georgia							
Griffin	60,000	2.60n	Sand and cement	...	...	1	Cement
Illinois							
Alton	15,750	2.75n	Concrete	5	...	...	...
East Moline	6,000	4.05n	Concrete	5	...	1	Cement
East St. Louis	13,223	2.31n	Concrete	6 and 7	...	⅝	Concrete
Gillespie	0.75	3.00n	Brick	4	...	none	Cement
Joliet	18,300	2.80n	Concrete	5	...	1½	Asphalt
La Grange	700	3.20m	Old macadam	...	...	1½	...
Peoria	4,500	2.60n	Concrete	4	...	1	Asphalt
Indiana							
Crawfordsville	2,410	2.75	Cement	4	...	1½	Cement
Elkhart	0.50	2.70n	Concrete	4	...	...	Cement
Fort Wayne	4,658	4.00n	Concrete	...	...	1	Cement
Greenwood	4,300	3.50n	Concrete	6	Grading $0.75	1	Cement
Lafayette	1,712	3.50	Concrete	4	...	1	Cement
Terre Haute	3.02	3.25	Concrete	5	...	1½	Cement
Iowa							
Clinton	11,000	4.15	Concrete	5	...	1½	Asphalt
Creston	11,000	4.09	Concrete	5	...	1½	Asphalt
Davenport	5,000	3.40n	Concrete	5	...	1	Asphalt
Dubuque	19,504	3.40n	Concrete	5	...	1	Asphalt
Mystic	8,000	5.10	......	6 and 7	...	1½	Sand
Kansas							
Atchison	19,000	3.80	Concrete	5	...	1	Asphalt
Council Grove	35,000	3.26m	......	5	...	1½	Asphalt
Salina	0.38	3.78	Concrete	6	...	1	Asphalt
Winfield	2.00	3.25n	Concrete	4	...	1	Asphalt
Kentucky							
Louisville	1,831	2.31	Concrete	6	...	6	P. C.
Maryland							
Cumberland	13,970	5.25	Concrete	5	...	...	...
Massachusetts							
North Adams	735†	2.24	None	...	...	1	Pitch
Michigan							
Ionia	3,716	2.15mn	......	6	0.92	1½	Cement
Midland	834	3.49n	Concrete	6	...	1	Cement
Missouri							
Kansas City	39,269	4.98	Concrete	8	...	...	...
Sedalia	18,294	2.21m	Concrete	6	...	1½	Asphalt
Nebraska							
Lincoln	9,470	3-in. 3.34; 4-in. 4.07	Concrete	5	...	1	Asphalt
New Jersey							
Bound Brook	630	5.00	Concrete	6	...	1	Cement
Plainfield	14,610	4.09n	Concrete	6	...	...	...
New York							
Albany	419	3.04n	Concrete	6	...	1½	Grout
Binghampton	9115	3.32	Concrete	6	...	½	Grout
Elmira	8,922	3.71	1:2½:5 Concrete	5	...	1½	Pitch
Geneva	10,000	4.30n	Concrete	5	...	1½	Cement
Niagara Falls	691	5.11	Concrete	6	...	½	Grout
Olean	37,000	2.00mn*; 2.25mn	Concrete	5	$6.10‡; 6.50‡	1½	Cement; Sand
Rochester	1,650	2.15mn	1:2½:5 Concrete	6	1.50	1	Grout
Salamanca	6,350	4.85	Concrete	6	...	1	Asphalt
New Jersey							
Bound Brook	1,200*	5.00	Concrete	6	....		Cement
Camden	11,600	6.00	....	..	....		....
Jersey City	2,000§	2.44	Concrete	6	....		Cement
New York							
Binghampton	1,589	6.87**	Concrete	8	....		Tar
Brooklyn	0.78	5.61*	Concrete	6	....		....
Fairport	738	4.25mn	Concrete	5	....		Cement grout
North Carolina							
Asheville	3,487	3.47*	Concrete	5	....		Cement grout
Ohio							
Akron	1.24	5.90	Concrete	5			....
Lakewood	31,650	3.70mn	Concrete	6 & 7			....
Pennsylvania							
Hazelton	10,030	1.93	Reconstructed Macadam	..	....		Amesita
Philadelphia	1,892	5.99*	Concrete	6	1.96		Bituminuous mostic
Pittsburgh	28,350	4.95n	....	6	....		Cement grout
West Homestead	0.50	6.34n	Concrete	6	....		Grout
Rhode Island							
Pawtucket	13,700	5.93	Concrete	6	....		Cement grout
Pawtucket	3,646††	3.75	Concrete	6	....		Cement grout
Indiana							
Portland	9,500	2.60	1:2½:5Concrete	6-8	....		....

*Includes grading.
†Does not include cost of old blocks used.
‡Old Philadelphia blocks turned.
§Belgian on concrete pavement with 1 in. cushion.
**$7.10 in R. R. area.
††Old granite, recut and relaid.
m Does not include base.
n Does not include grading or other work.

TABLE NO. 4—MISCELLANEOUS PAVEMENTS LAID IN CITY LIMITS DURING 1919.

City and State.	Kind of Pavement.	Yards or miles laid.	Aver. cost per sq. yd.	Remarks.
Connecticut:				
New Haven	National.	22,866	$2.04-2.19; 3.36	Resurfacing old mac. On 6-inch concrete.
Florida:				
Tampa	3-inch asphalt block.	5,579	2.47n	
Illinois:				
Granite City	4½-inch conc. sidewalk.	9,000	1.755	
Indiana:				
Bluffton	Asphalt block.	11,254	1.53	
Noblesville	Concrete sidewalks.	1,400	1.3	
Kentucky:				
Covington	Kentucky rock asphalt.	1,600	2.90n	
Maine:				
Rockland	Lime ashes.	24,620	0.14	
Missouri:				
Sedalia	3-in. vertical fibre brick.	2,000	3.00	Cushion ½ inch on 4-inch concrete base.
New Jersey:				
Collingwood	Concrete gutter.	10,000	2.00	
West Orange	National on 5-in. broken stone.	4,060	2.65	
New York:				
Brooklyn	Asphalt block.	0.13	2.96	Laid on old conc. found'n
Niagara Falls	Concrete repairing.	4,932	3.80	
North Carolina:				
Fayetteville	Sheet asphalt surfacing.	25,000	1.60	
Greensboro	Willite.	2,500	1.40	Exclusive of preparation of base 15c. per yd.
Pennsylvania:				
Freeland	Amiesite 2 inches thick.	6,085	2.861	With concrete base.
Miners Mills	Hastings' asphalt block	4,000	4.25	Concrete base.
Philadelphia	Split granite, redressed.	13,847	2.36	Cement grouted.
Pittsburgh	Asphalt block.	4,571	4.25n	
Texas:				
Beaumont	Oyster shells.	9,000	0.60	
Dallas	Uvalde rock asphalt.	14,918	2.60	
Washington:				
Aberdeen	Plank.	1,643	1.38	Some elevated.

nDoes not include grading or other work.

TABLE NO. 5—CONCRETE PAVEMENT LAID IN CITY STREETS DURING 1919.

City and State.	Yards or miles laid.	Average cost per sq. yd.	Number of courses.	Thickness, inches.	Proportions of mixture.
Alabama:					
Anniston	1,500	$2.00n	..	..	1:2:3
Colorado:					
Boulder	2,700	2.57a	1	6	1:2:3½
Longmont	15,000	1.62	1	6	1:2:4
Connecticut:					
New Haven	12,270	1.935n	1	6	1:2:4
Putnam	8,000	2.30m	1	7	1:2:3½
Georgia:					
Madison	29,000	3.15n	1	6-8	1:2:3
Illinois:					
Alton	576	2.55n	1	7	1:1½:3
East St. Louis	4,646	3.15n	2	9	1:1:1½ & 1:2½:4
Naperville	56,000	2.11b	1	6-8	1:2:3
Urbana	20,000	2.70n	1	7¼ average	1:2:3
Indiana:					
Lafayette	800	1.65	1	6	1:4½
Marion	427	....	2	6	....
Noblesville	810	2.10	1	7 average	1:2:3
Peru	100	1.75	1	..	2:4:6
Portland	1,600	2.50	1	..	....
Seymour	18,000	2.70	1	6-8	1:2:3
South Bend	3,068	2.271	1	7	1:2:3
Terre Haute	1.61	2.75	2	8-9	1:2:4
West Lafayette	550	1.80	1	6	1:5 gravel
Council Grove	2,580	2.00n	1	6	1:2:3
Iowa:					
Creston	2,500	3.18	1	6	1:1½:2½
Davenport	15,000	1.90n	1	6	1:2:4
Fort Dodge	3,500	2.42	1	7	1:2¼:4
Keokuk	12,330	2.45	1	7	1:1½:3
Mason City	35,112	2.49	1	7 reinforced	1:2:3
Kansas:					
Fort Scott	650	2.85	..	..	1:2:4
Salina	0.50	2.75	1	6-8	1:2:4
Kentucky:					
Covington	5,400	3.00	1	..	1:2:3
Louisville	Alleys only	....	1	6	1:2:3
Maine:					
Rockland	2,307	3.25c	1	6	1:2:4
Massachusetts:					
Adams	7,000	2.24n	..	6½-8	1:2:4
Brockton	7,236	3.42	1	4 Hassam	1:2:4
Lowell	0.2949	....	1	4 Hassam	....
Lynn	9,466	2.25	1	8	1:1½:3
North Adams	10,843	2.54	1	6-8	1:2:3
Peabody	49,859	2.885	1	8	1:2:4
Watertown	21,534	2.52n	1	6	....
Michigan:					
Alma	6,000	2.24n	1	..	1:2:3
Minnesota:					
E. Grand Forks	43,000	....	1	7	1:2:3
Red Wing	31,632	3.28	1	7-8	1:2½:4
St. Cloud	500	2.45	1	7	1:2:3
Virginia	12,620	2.39n	1	6	1:2:3
Missouri:					
Bethany	7,600	2.35	1	6-8	1:2:4
Kansas City	53,777	2.62	..	7½	1:2:3½
Sedalia	1,300	2.41	1	6 alleys	1:2:3
Nebraska:					
Fremont	1,900	2.43	1	6-7	1:2½:4
Lincoln	1,074	2.25	1	6	1:2:4
New Jersey:					
Bordentown	7,500	3.24	1	6-8	1:2:3
Camden	1,200	3.20	1	8	....
Collingwood	74,000	2.50	1	7	1:1½:3
Highland Park	5,000	3.00	1	7	1:2:3
Plainfield	2,313	13.75nf	1	6-8½	1:1¾:3
West Orange	4,500	....	1	7-11	1:2:4
New York:					
Binghamton	2,907	2.91	2	7	1:2:3
Geneva	500	5.00n	..	..	1:1½:3
Herkimer	6,726	2.70	1	6-8	1:1½:3
Little Falls	1,601	3.08n	1	6-8½	1:1½:3
Niagara Falls	1,888	4.35	1	8	1:2:3

TABLE NO. 5—CONCRETE PAVEMENT LAID DURING 1919 (Continued).

City and State.	Yards or miles laid.	Average cost per sq. yd.	Number of courses.	Thickness, inches.	Proportions of mixture.
Texas					
Dallas	20,455g	1.75	1	6	1:5½
Provo	34,258	2.25n	1	6	1:2:4
Washington					
Aberdeen	28,800	2.48n	1	7½	1:2:3
Auburn	25,000	2.32n	1	6	1:2:4
Bremerton	62,000	2.30n	1	7	1:2:3
Charleston	55,000	2.00	1	6	1:2:3
Wisconsin					
Appleton	638	3.15	1	8	1:2:3½
Baraboo	7,000	2.00n	1	8	1:2½:3
Beloit	9,130	1.99n	1	6-8	1:2:3
Delavan	23,350	2.33	1	6-8	1:2:3
Eau Claire	18,346	2.30	1	7	1:2:3
Edgerton	15,000	1.85n	1	6-8	1:2:3
Fond du Lac	360	2.60	2	6½	Top 1:1:1: / Base 1:2½:5
Grand Rapids	25,000	1.525n	1	6-8	1:2:3½
Kenosha	3,161	2.35	2	8	....
Madison	44,970	2.09n	2	6-8	Base 1:2½:4 / Top 1:1½:3
Racine	1,216	2.78	2	7	1:3:5
Waukesha	9,543	2.325	1	7	1:2:4
Clinton	18,000	2.25n	1	..	1:2:3½
Black Earth	13,000	2.25n	1	..	1:2:3½
Canada					
Charlotte, P.E.I.	10,000	1.50n	1	6	....

[a]Including excavation $0.70 and base $0.07. [b]Contract let in 1917 at pre war prices involving loss to contractor. [c]Includes 1,160 linear feet concrete curb. [d]Simpson Bros. compressed concrete. [f]Cost per cubic yard. [g]Vibrolithic. [n]Does not include grading or other work.

TABLE NO. 6—BITUMINOUS CONCRETE LAID IN CITY LIMITS DURING 1919.

City and State	Yards or miles laid	Average cost per sq. yd.	Base: Kind	Base: Thickness, inches	Base: Cost
California					
Porterville	40,290	$2.75	1:3:6 concrete	5	....
Illinois					
Chicago Hgts.	3,000	2.80	concrete	6	....
East Moline	17,000	1.68nm	concrete	5	$1.18
Joliet	40,200	2.33n	concrete	5	....
LaGrange	40,000	1.59m	old macadam	..	....
Peoria	9,500	1.58nm	old brick	..	....
Indiana					
Fort Wayne	86,821	1.95n	1:2:4 concrete	..	....
Muncie	32,265	2.40m	old macadam	..	....
South Bend	7,056	1.59	tarvia	5	....
South Bend	26,351	2.672	concrete	..	....
Iowa					
Cedar Rapids	5,661	2.70n	....	4	....
Davenport	200,000	2.60n	concrete	5	....
Kansas					
El Dorado	50,000	2.625n	concrete	5	....
Salina	1.50	2.30	concrete	5	....
Massachusetts					
Brockton	18,872	2.30	stone	3	....
Michigan					
Lansing	7,814	2.40	concrete	6	....
Midland	8,634	2.645n	concrete	6	....
Minnesota					
E. Grand Forks	43,000	....	....	5	....
New Jersey					
Elizabeth	0.81	4.25	concrete	6	....
Jersey City	56,314	0.90n	old macadam	..	....
New Brunswick	3,404	2.70n	old macadam	..	....
New York					
Albany	4,531	2.78n	concrete	6	....
Elmira	5,093	3.25	1:2½:5 concrete	5	....

Ogdensburg ...	7,097	....	1	6-8	1:2:4
Oneida	16,980	3.26	1	8 1-3	1:1½:3
Schenectady ...	9,522	2.80	1	7	1:1½:3
Watertown	25,000	3.00	1	8	1:1½:3
North Carolina:					
Asheville	11,997	2.43	1	6	1:2:4
Wahpeton	8,832	2.87n	1	7	1:2:3
Ohio:					
Akron	0.50	....	1	7-9	1:2:3
Akron	0.48	....	2	7-9	1:1¼:2
Bucyrus	1,487	3.00	1	6-8	1:2:3
Columbus	1,916	....	1	7 average	1:2:3
Lakewood	8,375	3.60n	2	7	Base, 1:2½:4 sl'g Top, 1:1⅓:2½ gr
Newark	2,100	2.18	1	7	1:2:4
Toledo	38,958	2.36n	1	6-8	1:2:3 reinf'd
Pennsylvania:					
Franklin	18	2.70	1	6	1:2:3
Lebanon	8.28	2.84	1	6	1:1½:3
North East.....	1,262	3.09	1	6-8	1:1½:3
Pittsburgh	5,355	2.36n	..	..	1:2:3
Somerset	2,500	4.00n	1	7-10	1:2:3
South Dakota:					
Sioux Falls.....	6,400	2.80	..	..	1:2:4
Tennessee:					
Jackson	5,300	2.65	1	6	1:2:3

Fairport	4,926	**1.85nm**	concrete	5	....
Niagara Falls ..	2,356	4.66	concrete	6	....
Salamanca	2,325	4.25	stone	8	....
North Carolina					
Asheville	8,205	2.68	concrete	4	....
Ohio					
Akron	1.92	3.80	concrete	6	....
Perrysburg	16,171	2.40n	concrete	6	....
Oklahoma					
Oklahoma City.	22,770	3.35n	concrete	4	....
Pennsylvania					
Osborne	12,550	2.00mn	old macadam	..	....
Philadelphia ...	44,285	2.59	concrete	6	....
Rhode Island:					
Pawtucket	25,344	3.33	concrete	5	....
Pawtucket	2,612	3.33	concrete	5	....
Vermont:					
St. Albans	1,190m	1.25m	waterb'd mac.	6	....
Virginia:					
Covington	6,663	1.94	concrete	5	....
Washington:					
Aberdeen	10,560	1.88m	concrete	5	2.25
Wisconsin:					
Fond du Lac....	21,254	2.36	1:3:6 concrete	5	....
Racine	9,300	2.50	concrete	5	....

m Does not include base. n Does not include grading or other work.

TABLE NO. 7—RESURFACING PAVEMENTS.

City and State.	Kind of Pavement Resurfaced.	Years in Service Before Resurfac'g	Kind of Traffic Carried.	Material Used for New Surface.	Treatment of Old Pavement Before Resurfacing.	Cost of Resurfac'g per sq. yard.	Use Made of Old Material.
Alabama:							
Anniston	Bitulithic.	12	Business.	Asphalt seal coat.	Cleaned and painted with cut-back asphalt.	....	None removed, except holes cut for patches.
Selma	Brick.	10	Business.	Same bricks, turned over.	Conc. base repaired, brick relaid on sand-cement & grouted.	$1.00	Only a few bricks not used.
California:							
Alameda	Oil macadam	5 to 15	Residence.	98% asphaltic oil.	Scarified, leveled with new stone, rolled, oiled, screened and rolled.	$0.135	Used in the same job.
Connecticut:							
Manchester	Plain macadam.	....	Residence.	Hot refined tar, 1 gal. per sq. yd., and ¾" trap rock.	Patched with tarvia and ½" stone.	0.29	....
Middletown	Plain macadam.	....	Residence.	Tar penetration macadam.	Scari'd, shaped with grader.	1.15	All used in the job.
New Haven....	Plain macadam.	8 to 15	....	Sheet asph. and "National," 1½" binder and 1⅛" surface.	Scarified, shaped, cross-walks removed, depressions filled with No. 2 stone, sand-filled & rolled.	....	For fill only.
Putnam	Gravel.	....	....	Concrete.	....	....	Resurfacing other streets.
Illinois:							
Danville	2-course brick.	28	Heavy business.	Brick, asphalt filler.	Removed top course & sand cushion, spread min. of 3" of 1:6 conc., ¾" sand cush.	2.92	Patching existing pavements and filling.
East St. Louis..	Brick.	17	Through.	Asphalt, 1" binder, 2" surf.	Brick & cush. removed, new cement conc. on old base.	3.20	None.
Peoria	Brick.	24 to 30	Business.	Sheet asphalt, 1" binder, 1½ top.	Well swept, depressions filled with binder, light paint coat of asphalt.	1.75	None.
Indiana:							
Bluffton	Sheet asphalt.	24	Thoroughfare.	Asphaltic conc.		1.58	....
				Asphalt block.	Asphalt and 4" of old conc. base removed and 4" of new conc. laid.	3.28	None.
		22	Residence.	3" asphaltic macadam.	Asphalt removed, concrete scarified and 1" removed.	1.38	None.
Elkhart	Macadam.	10	Residence.	Sheet asphalt.	Crown reduced, leveled up with binder.	1.87	....
Fort Wayne....	Brick.	**26**	**Heavy.**	Shale **brick.**	Old brick and base entirely removed.	4.00	....
Marion	Macadam.	15 & 16	Both.	Stone.	....	1.40 per ton[a]	....
Muncie	Mac. & sheet asph	**13**	**Business.**	Asphalt.	Old sheet asphalt removed.	2.70	....
Peru	Bitulithic.	2	Residence.	Bitulithic.	Old surface removed.	1.80	Dumped.
Seymour	Gravel & earth.	10 to 20	Both.	Concrete.	Scarified and rolled thoro'ly	2.70	For shoulders and filling.
South Bend....	Tarvia macadam.	**10**	**Residence.**	Asphalt concrete.	Surface removed, base scraped and rolled.	1.59	....
Terre Haute....	Brick.	**26**	Business.	Brick.	Old brick removed, base leveled up.	2.74[b]	Sewer manholes, building found. and patching.

TABLE NO. 7—RESURFACING PAVEMENTS (Continued).

City and State.	Kind of Pavement Resurfaced.	Years in Service Before Resurfac'g	Kind of Traffic Carried.	Material Used for New Surface.	Treatment of Old Pavement Before Resurfacing.	Cost of Resurfac'g per sq. yard.	Use Made of Old Material.
Iowa:							
Atlantic	Asphalt & conc.	Asph. 8, conc. 5	Both.	Tarvia & crushed stone.	....	....	....
Davenport	Brick.	25	Residence.	Asphalt concrete, 1½".	Rolled & swept, minimum of 1" binder.	1.88	....
Dubuque	Macadam & brick	Mac. 40, brick 20	Both.	Bitulithic.	Macadam brought to crown.	2.35	Used in the same job and repair other streets.
Fort Dodge....	Brick.	15	Both.	Wood block.	Cement cushion ½" to 1" on old concrete.	3.80	Filling.
Iowa City......	Bitulithic.	8	Both.	"Bitustone."	Painted base with cement.	2.00 to 6.00	Old surface worn away.
Waverly	Asphaltic conc.	6	Both.	Bitulithic.	Concrete added to base where necessary.	3.42	....
Kansas:							
Atchison	2-course brick.	30	Residence.	3" vertical fiber brick.	Top course removed, depression in bottom filled with concrete.	2.28	None.
Kentucky:							
Covington	Brick.	16	Business.	Kentucky rock asphalt, 2"	Brick surface thoroughly cleaned.	2.90	None removed.
Massachusetts:							
Brockton.......	Bitulithic.	15	Both.	"Willite," 2".	High points removed to give 2" depth.	1.85	....
Lee	Plain macadam	18	Business.	Tar macadam.	Scarified, old stone screened and new added, leveled and rolled.	1.20	Used in same job.
						1.00	....
New Bedford...	Plain macadam, Bitulithic.	 16	Both. Both.	Asbestos bit.	Cleaned holes filled with binder, painted.	.... 2.00	Used for plain macadam, light travel.
Peabody	Plain macadam.	5 to 10	Both.	Concrete & granite block.	....	....	Best used to resurface light-traffic streets.
Springfield	Plain macadam.	15 to 25	Both.	Asphalt.	Scari'd & brought to grade.	1.25	For base on other streets.
Waltham	Macadam.	10	Both.	Bituminous macadam.	Scarified, new stone added, shaped, rolled.	.65	Side streets.
Watertown	Tar macadam	8	Both	Oiled and sanded.	Levelled and rolled.	....	....
Michigan:							
Alma	Concrete.	2	Business.	Tarvia A.	....	....	....
Midland	Macadam.	17	Both.	Sheet asphalt.	Binder used to get uniform surface.	1.79	None removed.
Missouri:							
Kansas City....	Brick	19 to 27	Business & both.	Sheet asphalt	Brought to surface by raising brick or filling with concrete and smearing with asph. concrete.	2.43	....
	Macadam.	10	Both.	Bituminous concrete.	Scarify & remove top 2½".	1.02	....
	Sheet asphalt.	12 to 25	Business & res.	Sheet asph., 1½" binder, 1½" surface.	Remove old asphalt, fill holes in base with concrete, or with binder if shallow.	....	....
Sedalia	Brick, asphalt, stone block.	25 & 28	1 business, 2 res.	Brick block, vert. fiber brick, asph. macadam.	Old surface removed, base thoroughly cleaned and brought to uniform surface with new concrete.	2.21	200,000 brick used for backing and rear walls in buildings.
Nebraska:							
Lincoln	2-course brick.	28, 27 & 28	Bus., res., both	Asphaltic concrete.	Top course removed, holes over 1" deep concreted; if shallower filled with top material.	1.09	Buildings and sewers.
New Jersey:							
Bound Brook...	Plain macadam.	19	Through business.	Tar macadam.	Scarified, small stones & dirt removed, rolled.	0.96	Resurfacing dirt streets.
Collingwood ...	Macadam.	11	Both.	Slag and asphalt.	Swept, patched.	....	Fill.
Garfield	Plain macadam	15	Both.	Asphalt macadam, 1"	Swept, scarified, repaired.	.58	Very little removed.
New Brunswick	Dollarway	6	Residence.	Tarvia A & screenings.	Concrete surface cleaned with brooms.	.45	....
Passaic	Asphalt macad.	6½	Both.	Asphalt & ⅝" trap.	....	.34	....
Plainfield	Plain macadam	16 & 20	Residence.	Tarvia X.	Scarified & shaped with new stone.	1.20	None removed.
Summit	Plain & asp. mac.	....	Residence.	Tarvia B & sand.	Swept clean.	.06¾	None.
Wallington	Plain macadam	20	Both.	Tarvia K P.	Holes cleaned and patched.	....	None.
Westfield	Macadam.	12	Residence.	Tar macadam.	Scarified.	.55	None.
West Orange...	Plain macadam.	20	Business.	Bitulithic & bitoslag.	Scarified if grade correct. Otherwise taken up, graded and relaid.	2.55 & 2.65	In adjoining streets for repairs.
New York:							
Binghamton ...	Brick.	16	Business.	Asphalt macadam.	Very carefully cleaned; flush-coated with hot oil.	.35	....
Brooklyn	Asphalt.	13 to 22	Both.	Asphalt.	Surface heated and ½" scraped off.	1.70	None.
Ellenville	Plain macadam	20	Both.	Bituminous macadam.	Cleaned, holes filled and rolled.	....	None.

TABLE NO. 7—RESURFACING PAVEMENTS (Continued).

City and State.	Kind of Pavement Resurfaced.	Years in Service Before Resurfac'g	Kind of Traffic Carried.	Material Used for New Surface.	Treatment of Old Pavement Before Resurfacing.	Cost of Resurfac'g per sq. yard.	Use Made of Old Material.
Geneva	Plain macadam	10	Residence.	Asphalt macadam.	Thoroughly cleaned.	1.30	....
Little Falls....	Macadam.	3 to 5	Business.	Oil mat.	Scarified.	....	....
Niagara Falls..	Asphalt.	14	Both.	Asphalt concrete.	Old surface removed.	....	....
Rochester	Macadam.	16	Residence.	Sheet asphalt, 2", binder 1"	Removed some material to get proper crown; filled large holes with 1:2½:5 concrete, small ones with binder.	Asph. 1.15 Binder 9.75 per ton.	None.
	Brick.	25	Residence.	Sheet asphalt, 2", binder			
	Medina stone.	30	Residence.	Sheet asphalt, 2", binder			
Schenectady ...	Brick.	20	Residence.	Asphalt.	Swept clean.	1.85	....
North Carolina:							
Fayetteville ...	Macad. & gravel.	3 to 8	Both.	1½" sheet asphalt on macadam, stone chips & bitumen on gravel.	Holes in macadam filled with binder & paint coat applied.	1.60	On old dirt streets.
Greensboro	Macadam.	15 to 20	Business.	Bitulithic.	Dirt removed, low places filled with binder.	1.55[d]	None.
Ohio:							
Akron	Creosoted wd. blk.	4	Business	Granite block.	Blocks failed completely. Base removed because stone blocks deeper.	....	Wood burnt, concrete to fill in dirt streets.
Columbus	Brick.	30	Residence.	Sheet asphalt.	Thoroughly cleaned, joints raked out, binder where needed.	2.40	None removed.
Lakewood	Brick.	20	Residence.	Bitulithic, 2".	Low places filled with bitulithic binder, new concrete where foundation was especially poor.	1.65[e]	None.
Oklahoma:							
Bartlesville ...	2-course brick.	8 and 12	Business.	Brick.	Foundation repaired with concrete where necessary	....	....
Pennsylvania:							
Altoona	Asp. block & brick.	Asph. 7, brick 15	Business.	Same as old.	....	....	Good ones saved for repair work.
Erie	Asp. on conc.	20	Both.	Sheet asphalt.	Low spots in foundation filled with bit. concrete.	2.15	None.
Freeland	Macadam.	5 to 8	Both.	Gravel and oil.	....	0.436	Repair work in alleys.
Greensburg	Shale block.	26	Business.	Shale block.	Old block, cushion and part of old foundation taken up, bed well rolled, new 5" concrete base put in dry, 1" of 1:3 dry cement mortar hand rolled, sprinkled after brick set.	2.81 for new blks 1.98 for old blks.	Half the old block relaid; balance used for fills.
Harrisburg ...	Sheet asphalt.	20	Both.	Sheet asphalt.	Asphalt removed.	1.50	....
Hazleton	Brick.	13	....	Amiesite.	Cleaned, depressions filled with concrete.	1.78	....
Media	Plain macadam.	4 or 5	Both.	Tar macadam.	Scarified.	....	Foundation course or filling.
Norristown	Plain macadam.	5 to 11. 15 to 30.	Residence / Business	Seal coat & ¼" slag.	Scarified deep, dirt removed, slag spread and rolled, good stone forked, spread and rolled.	.70	
Osborne	Macadam.	10.	Both.	Asphaltic concrete.	Scarified and graded.	2.35[f]	....
Pittsburgh ...	Irregular blkstone	15.	Residence.	Brick.	6" concrete in place of old gravel base.	3.83	Broken stone for curb drain.
Reading	Brick	15.	Both.	Sheet asphalt.	....	1.95	Old brick for gutters and crossings.
Shippensburg ..	Macadam.	50.	Both.	Macadam.	Scarified 6" deep.	....	On side streets.
Tyrone	Plain macadam.	....	Residence.	Screenings and oil.	Holes swept clean.	....	None removed.
Tennessee:							
Clarksville	Plain macadam.	18	Business.	Bituminous macadam.	Scarified, graded & rolled.	.37	....
Texas:							
Dallas	Bitulithic.	10	Semi-business.	Bitulithic.	Roadway widened from 30' to 44'; new foundation at sides, new 2" surface on top of old.	1.50	....
	Wood block.	7	Residence.	2" bitulithic on 2" binder.	Wood blocks removed. New pavement on old base.	2.25	....
Houston	Creosoted wd blk.	8	Business.	2" bitulithic on 2" binder.	Base patched where necessary.	2.75	Blocks too badly broken for use.
Longview	Plain macadam.	6	Both.	Asphalt surface coat.	Scarify, add new rock and screenings.	.35	None removed.
San Antonio ...	Cre. wood blk.	3 to 4	Business.	Creosoted wood block.	Old blocks removed, some relaid.	2.15 & 4.20	....

TABLE NO. 7—RESURFACING PAVEMENTS (Continued).

City and State.	Kind of Pavement Resurfaced.	Years in Service Before Resurfac'g	Kind of Traffic Carried.	Material Used for New Surface.	Treatment of Old Pavement Before Resurfacing.	Cost of Resurfac'g per sq. yard.	Use Made of Old Material.
Vermont:							
Middlebury	Gravel & pl. mac.	....	....	Same material.	....	.80	....
St. Albans	Plain macadam.	7	Both.	Tar concrete.	Depressions brought up to grade.	....	....
Virginia:							
Danville	Bitulithic.	9[g]	Residence.	Asphalt.	....	....	....
Wisconsin:							
Fond du Lac...	Brick, sand filler.	21	Both.	Old brick relaid.	Filled depressions in base with concrete; cushion of 1:5 dry mortar.	1.48[h]	Bricks scraped clean, washed with hose, laid upside down.
Lake Geneva...	Gravel.	8	Heavy through.	Gravel.	Scarified and rolled.	....	None removed.
Marinette	Macadam.	22	Residence.	Macadam.	....	....	....
Waukesha	Tar macadam	10	Both.	Gravel and asphalt.	Swept clean.	.20	None removed.

[a]—for stone; work done by city street gang. [b]—plus about 50 cts. per sq. yd. for stone for base. [c]—holes cleaned, loose stone removed, sides cut vertical, filled with broken stone from 2½" to 1", tamped solid, painted with a coat of Tarvia KP, ¼ to ½ gal. per cu. yd. On this was placed a mixture of 1 part sand, 3 parts ¾" stone, and 16 gal. of Tarvia KP to fill the hole; tamped with heavy iron tamper till level with pavement; seal coat of Tarvia KP covered with screenings. [d]—$1.40 for bitulithic, 15 cts. for preparation of base. [e]—Also $10 per ton for binder. [f]—$2 for surface, 35 cts. for preparing base. [g]—Resurfaced four times since 1910. [h]—Average for 4,670 sq. yds., including 11,000 new brick.

TABLE NO. 8—TAR OR ASPHALT MACADAM LAID IN CITY STREETS DURING 1919.

City and State.	Yards or miles laid.	Av.cost, sq. yd.	Thickness, inches,	Gallons, per sq. yd.
California:				
Alameda	1,000	$2.86	6	1½
Connecticut:				
Manchester	5,185	1.32n	..	2½
Middletown	9.126	1.30	3	3
Illinois:				
Danville	17,000	1.98n	1	2
Indiana:				
Bluffton	5,172	1.38	3	1 per inch
Iowa:				
Dubuque	1,800	1.35n	..	1¾-2
Kansas:				
Salina	0.12	1.57	..	2¼-2 1-5
Kentucky:				
Covington	1,000	2.50n	10	2½
Maine:				
Auburn	0.500	1.30n	6	2½
Massachusetts:				
Arlington	4,100	3.00	6	2¾
Brockton	20,236	1.90	4	2¼
Lowell	0.2753	...	3 or 4	1½
Lynn	54,632	1.40	3 and 4	2¼
New Bedford...	21,274	1.80	6	..
Peabody	3,861	1.25	3	2¼
Springfield	27,000 tar	1.30	2	1½
Springfield	10,000 asph.	1.40	2	1½
Waltham	15,800	0.65	4	2½
Minnesota:				
Faribault	10,850	0.30n	..	..
Missouri:				
Kansas City....	3,530	1.73	..	2-2½
Sedalia	680	1.15n	2½	2
New Jersey:				
Bound Brook...	1.5	0.96	4	1.83
Garfield	3,780	1.15	7	2½
Summit	1.730	0.80	3	2 Tarvia X
Westfield	6,700	1.58	4-6-7	½ to ¾
West Orange...	28,000	1.90	7	3
New York:				
Binghamton ...	24,525	...	6 base 2 top	2
Elmira	1,859	...	3	2½
Geneva	7,500	1.30n	..	2¼
Poughkeepsie ..	0.56	2.61	7	3
Rochester	6,100	2.10n	8	2¼
Ohio:				
Akron	0.85	...	..	..
Columbus	6,000	...	..	2½
Pennsylvania:				
Norristown	18,500	0.70	6-8	2¼
Philadelphia ...	4,815	2.87	8	2-2½
Rhode Island:				
Pawtucket	27,700a	...	..	...
Texas:				
Gainesville ...	50,000	1.23n	6	0.6
Wisconsin:				
Waukesha	14,777	2.145	8½	2½

a—Partly temporary work to last a year or two until permanent work has been planned. n—Does not include grading or other work.

TABLE NO. 9—GRAVEL PAVEMENT LAID IN CITY STREETS DURING 1919.

City and State	Yards or miles laid	Average cost per sq. yd.	Thickness, inches
Alabama			
Selma	0.50	....	..
Connecticut			
Putnam	1,000	$0.40	7
Indiana			
Greenfield	3.0	2.50 cu. yd.	6
Lafayette	12,300	1.05	8-12
Peru	1.0	0.30	..
Louisiana			
Kentwood	2.0	0.284	6
Maine			
Auburn	0.75a	....	4
Massachusetts			
Lowell	3.23	....	6
Waltham	50,000b	0.18	4
Watertown	1.50c	1.35	6-8
Minnesota			
Faribault	5	....	6
Montevideo	9	....	8
New Jersey			
Atlantic City	13,230c	0.74	6
Millville	1.0	....	6
New York			
Herkimer	4,210	0.80	5
Ohio			
Sciotoville	1,500	1.00	8
Pennsylvania			
East Bangor	5,000d	0.30	3

a—Surface 4-inch rolled on 8-inch stone base; cost, $12,000 per mile. b—Rolled and oiled. c—Rolled. d—Resurfaced. n—Does not include grading or other work.

TABLE NO. 10—BITULITHIC PAVEMENT LAID IN CITY STREETS DURING 1919.

City or State.	Yards or mi. laid.	Aver. cost per yard.	Base: Kind.	Base: Thickness Inches.
Iowa:				
Albia	26,000	3.84	Concrete.	5 to 7
Centerville	47,000	3.77	Concrete.	5 to 7
Dubuque	56,500	2.99n	Concrete.	..
		2.35n	Macadam.	..
Reinbeck	38,000	3.22	Concrete.	4
Fort Dodge	10,000	3.42	Concrete.	5
Tama	57,000	3.23	Concrete.	5
Waverly	22,000	3.42n	Concrete.	5
Massachusetts:				
New Bedford	62,274	2.00m	Crushed stone.	5
Minnesota:				
Fairmont	30.278	3.33n†	1:3:5 concrete	6
St. Cloud	43,296	2.74	Concrete.	5
Virginia	10,734	3.63n	Concrete.	6
Montana:				
Billings	74,982	2.48n	Concrete.	5
New Jersey:				
West Orange	25,000*	2.55	Old macadam.	5
West Orange	700	3.42	Broken stone.	
New York:				
Rome	27,000	3.05	Concrete.	4
North Carolina:				
Greensboro	44,200	1.40m	Concrete.	4
North Dakota:				
Wahpeton	31,931	3.15n	Concrete.	5
Ohio:				
Lakewood	27,158	1.65nm	Concrete.	6
		2.12nm		8
Pennsylvania:				
Lebanon	10,900	3.60	Concrete.	5
Texas:				
Dallas	58.904	2.60	......	5
Houston	12,715	3.12mn	Rein. concrete.	
Houston	4,098	2.25mn	Old concrete.	5
Utah:				
Ogden	38,946	2.25n	Concrete.	6

†Including grading and drainage and exclusive of curb and gutter, $4.33. *Resurfacing, 2-inch. m Does not include base. n Does not include grading or other work.

TABLE NO. 11—MACADAM LAID IN CITY STREETS DURING 1919.

City and State	Yards or miles laid	Average cast per sq. yd.	Thickness inches.
Connecticut:			
Manchester	14,759	$0.47[a]	5
Putnam	1,000	0.80[a]	7
Iowa:			
Dubuque	[t]2,522	0.90[a]	....
Massachusetts:			
New Bedford	4,740	0.72	6
Peabody	3,300	0.55	4
Springfield	3,000	1.01	6
Waltham	[s]20,000	0.40	4
Minnesota:			
Virginia	[a]3	....	....
New Jersey:			
Garfield	[b]23,380	0.58	....
Summit	10,560	0.75	3-4 new
Wallington	[c]66	12.50	....
New York:			
Ogdensburg	25,000	....	3-5 resurfacing
Sidney	1.00	3.00	....
Watertown	20,00	1.00	6
Pennsylvania:			
Shippensburg	6,000	....	8
Wisconsin:			
Lake Geneva	[d]2,400	0.50	5
Manitowoc	15,000	1.10	6
Marinette	[e]20,120	0.30	4
Portage	3,000	1.20	....

[a]Scarified and treated with Tarvia B.
[b]Repaired and resurfaced.
[c]Repaired and patched with Tarvia K.P.
[d]Gravel mixed with stone crushed ni city's plant.
[e]Repairs on old macadam.
[n]Does not include grading or other work.
[s]Sealed on surface with asphalt and chips.
[t]Telford base used.

TABLE NO. 12—LABOR AND CONTRACTING.

City and State	Increase in Cost, percentage	Common labor: Available	Prevailing price in 1919: Per hour or day	Prevailing price in 1919: Hours per day	Kinds of pavement laid by day labor	Kinds of pavement laid by contract
Alabama.						
Anniston	.....	100-500	$2.50-$3.00	10	none	....
Selma	20	50	2.00	9	none	all
Troy	87	....	....	..	....	....
Arkansas.						
Fort Smith	35-50	....	3.00-3.50	8 & 10	....	....
California.						
Alameda	.....	....	4.00	8	none	....
Orange	10-25	....	3.50-4.00	8	....	....
Pomona	50	sufficient	....	..	....	....
Portersville	50	sufficient	4.00	8	none	all
Colorado.						
Boulder	80	200	3.25a	8	none	all
Longmont	50	variable	4.00	8 or 9	none	all
Connecticut.						
Bristol	.....	....	4.50	9	....	....
Manchester	50	50	4.14	9	plain macadam	tar macadam
Middletown	.....	....	3.50-5.00	8-10	all	none
New Haven	15-50	....	4.50	9	none	all
Putnam	100	....	0.50	9	gravel & macadam	concrete
Glorida.						
Tampa	40	....	3.00	9	none	all
Georgia.						
Dublin	50-80	100	2.50	10	none	all
Elberton	.....	very few	0.30	..	....	....
Griffin and Madison	38-60	....	0.40	..	none	all
Waycross	.....	100	3.00	10	....	....
Illinois.						
Alton	75	....	3.20	8	none	all
Canton	.....	100	4.00	8	....	....
Chicago Heights	45	200-300	57½	9	none	all
Carlinville	90	150	4.80	8	none	all
Collinsville	.....	150	0.50	8	none	....
Danville	75	....	0.45	9	none	all
DeKalb	.....	....	0.60	9	....	....
East Moline	40	....	4.00	9	none	all
East St. Louis	.....	....	4.00-5.40	8	tarvia patch	asphalt, brick and concrete
Fulton and Morrison	.....	20	0.50	8-9	....	....
Gillespie	63	50	4.00	8	none	all
Joliet	12	....	0.70	..	none	all
La Grange	25	....	5.60	8	none	all
Murphysboro	60	....	4.00	8	none	all
Naperville	40	....	4.50-5.40	9	none	all
Peoria	50-60	....	0.40	9	none	all
Urbana	75	....	4.50	9	none	all
Waukegan	10 (brick)	80	5.60	8	none	all
Wheaton	40 (labor)	none	0.70	10	....	....
Indiana.						
Bluffton	50-75	60-75	5.00	10	none	all
Crawfordsville	96	250	4.00	10	none	all
Crown Point	.....	10-25	4.00	8	....	....
Elkhart	20	50	4.00	10	none	all

TABLE NO. 12—LABOR AND CONTRACTING (Continued).

City and State	Increase in Cost, percentage	Common labor — Available	Common labor — Prevailing per hour or day	Common labor — Price in 1919 hours per day	Kinds of pavement laid by day labor	Kinds of pavement laid by contract
Fort Wayne	30-100	very few	5.50	10	none	all
Greenfield	.....	scarce	4.00	10	gravel	....
Greenwood	85	60	4.00	10	none	all
Kendalville	....	....	5.00	10	....	....
Lafayette	43	200	4.00	9	none	all
Marion	....	....	.45	10	....	....
Muncie	80-100	none	4.00	8	none	all
Noblesville	20	25-30	....	..	none	all
Peru	....	100	3.50	10	none	all
Portland	....	25	3.50	10	none	all
Seymour	100	200	3.50-4.50	10	none	all
South Bend	86.7	fair supply	5.95	9	none	all
Terre Haute	50	....	3.20	8	none	all
W. Lafayette	60	....	.35	..	....	....
Iowa						
Atlantic	100	very few	5.00	10	none	all
Boone	....	scarce	4.00	8	....	....
Cedar Rapids	....	....	.50	9	none	all
Centerville, Albia and Mystic	100-150b	....	.45	..	none	all
Council Grove	....	....	4.00	8	none	all
Clinton	100	75-100	4.00	8	....	....
Creston	100	....	4.00-5.00	10	none	all
Davenport	40-50	....	4.00	10	none	all
Denison	....	....	3.00	10	none	....
Dubuque	50c	....	5.00	10	none	all
Emmetsburg	....	50	4.50-5.00	10	none	all
Estherville	....	50	6.00	10	none	all
Fort Dodge	100-125	....	.50-.75	..	none	all
Iowa City	100	1,500	3.60	9	none	all
Jefferson	....	....	5.00	10	none	all
Keokuk	100	....	4.50	10	none	all
Le Mars	....	50	4.50-6.00	10	none	all
Mason City	....	....	5.50	10	none	all
New Hampton	....	very few	4.00	10	none	all
Tama	60	20	5.50	10	none	all
Waverly	39	50	4.00-5.00	10	none	all
Kansas						
Atchison	80	....	3.00-4.00	8	none	all
Chanute	125	100	3.50	8	none	all
El Dorado	95	....	4.00	8	none	all
Fort Scott	150	none	.50	8	none	all
Manhattan	138	....	4.00-5.00	8	none	all
McPherson	....	....	4.00	8	none	all
Osawatomie	....	very few	4.00	8	none	all
Salina	75	150	4.00	8	none	all
Winfield	100	....	.40	8	none	all
Kentucky						
Covington	60	250	3.50	8	none	all
Frankfort	....	40-50	3.00	9	none	all
Louisville	100	....	3.50	10	none	all
Louisiana						
Kentwood	25	50	2.75	10	none	all
New Orleans	....	....	4.45	9	none	all
Maine						
Auburn	....	....	4.05	9	gravel	brick & macadam
Rockland	30	....	3.50	9	none	all
South Paris	....	....	3.00	9	none	all
Maryland						
Easton	....	200	3.25	9	none	all
Massachusetts						
Adams	80	50	3.25	8	none	all
Arlington	....	100	4.00	8	none	all
Brockton	50-75	....	4.00	8	granite block & bit. macadam	sheet aspnalt. bit. concrete & concrete
Lee	....	very few	3.20	8	none	all
Lowell	....	....	4.00	8	none	all
Lynn	....	....	4.36	8	all	none
New Bedford	90	none	4.40	8	plain & bit. macadam	bitulithic & granite block
North Adams	90	scarce	3.50	8	....	....
Peabody	65	200	5.85	9	....	....
Springfield	30	....	4.00	8	all	none
Waltham	35	none	4.00	8	all	none
Watertown	30	....	4.50-5.00	8	gravel	concrete & granite block
Michigan						
Alma	....	scarce	5.00	10	none	none
Flint	33⅓	....	5.00	10	all	all
Ionia	80d	....	4.50	10	none	none
Lansing	90	....	5.40	9	sheet asphalt	....
Midland	....	....	3.00	9	none	all
Minnesota						
Albert Lea	....	200	5.00	10	....	....
Brainerd	....	100	4.00	8	....	....
E. Grand Forks	....	....	.50	..	....	....
Fairmont	53	50	5.00	10	none	all
Faribault	50	....	5.00	10	all	none
Hibbing	....	....	4.50	8	....	....
Montevideo	....	....	4.00	8	....	....
Red Wing	118	25	3.60	9	none	all
St. Cloud	15	....	4.50-5.00	10	none	all
Virginia	....	....	5.00	8	none	all
Willmar	....	....	.50	..	....	....

a—City rate; others, $3.50. b—Bitulithic, 100; brick, 150. c—On brick and bitulithic; none on macadam. d—Compared with 1912; 68% more than 1916, 35% more than 1917. e—Bituminous macadam, 53; concrete and brick, 140; asphalt, 102; granite block, 153. f—Asphalt, 50; brick, 80. g—$3.00 municipal for 8 hours, $4.75 private for 9 hours. h—Brick, 28; concrete, 43. i—Granite, 52; sheet asphalt, 128. k—Bitulithic, 44; brick, 57. l—Water-bound macadam, 80; concrete, 100. m—Brick, 75; concrete, 125. n—Concrete, 23; asphalt, 30.

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Publisher's Announcement

"Municipal Journal & Public Works," a weekly, and "Contracting," a semi-monthly publication devoted to construction, have been merged into one paper under the title of PUBLIC WORKS, and this is the first number of the combined papers.

PUBLIC WORKS will be issued weekly and, as the comprehensive name indicates, it will be devoted to public works—their design, construction, and maintenance—and to advance contract news relating to its field. The best features of both papers will be retained and no subject heretofore covered will be neglected.

With the editors of both publications concentrating their efforts upon one, those interested in public works will have at their command a better and more useful paper than either was when published separately.

It is the firm determination of the publishers and editors to make this paper indispensable to those who desire to keep abreast of the times so far as public works are concerned.

The outstanding feature of a class paper should be the dependability of the information published. If the statements that appear in its pages are not authoritative and of practical value, they are worse than useless. A busy man has no time to waste in reading articles dealing with impractical theories and schemes, or diffuse descriptions of unimportant details. He wants real information, concisely given, which will help him to do the work he has undertaken, better and more economically.

That is the kind of service Public Works will give, and upon that it bases its plea for the support of those interested in its field.

What of the Old Pavements?

The greatest problem of the street department, bureau of highways, or whatever the name, in every well-paved city (and will any today admit that it is not in this class?) is the keeping of its pavements in good condition. Money invested in pavements gives returns in the form of facilitating vehicular traffic, and this return diminishes as the square or some higher power of the number and depth of holes and other irregularities that grow in its surface with use.

Use is bound to bring deterioration and necessitate repairs, no matter what the kind of pavement; and the investment made by a community in a pavement becomes less gilt-edged as these repairs are neglected. Repairing is in many cases more difficult, both to plan and to perform, than is new construction. We believe, therefore, that we could present nothing in these pages that would be of more value to paving officials and contractors than articles dealing with this subject. A general review of the subject is given in the leading article this week, and we purpose to publish, during the next few weeks, a series of articles describing methods employed in different cities and for the various kinds of pavements. Any who can contribute to this information from their own experiences by sending descriptions of them to this journal for publication, will confer a benefit upon paving men generally, and we will welcome all such communications.

Water Works Pumping

The use of electric motors and internal combustion engines for operating water works pumps is of comparatively recent date, but a considerable number of such pumping plants now operate by these newer motive powers, and the number is continually increasing. There can be no question, however, that under some conditions steam power remains the more desirable. There is the danger that many, learning of the satisfactoriness of one or another of these types at other places, may unquestioningly conclude that it would be best for their own also; which does not necessarily follow.

In order that those having this matter under consideration may benefit by the experiences of others and learn the conditions under which each type has proved most satisfactory, we are intending to publish a series of articles giving such information, furnished by the superintendents of a number of plants where two or more types of plant are being or have been used. The first of these articles will be found in this issue, beginning on page 70.

Creditable Subaqueous Tunneling Under Difficulties

The restriction of delay until the completion of the work that is sometimes enforced for engineering construction fortunately does not apply to the interesting operations of the 14th street subway tunnels, New York. Although this work is still in an incomplete condition, the critical stages have been passed and as all of the excavation methods have been thoroughly worked out and those operations practically finished, we are able to review them and in this issue describe the principal features of the subaqueous tunnelling that ranks among the most advanced and important examples of its type.

The work was prosecutted successfully under very difficult conditions, namely, driving a large heading through very soft, wet material; and partly through such material and partly through overlying rock at the same point. It was necessary to work under heavy pneumatic pressure to expel ground water from the heading, and for a considerable distance the bed of the river was not adequate to resist the upward pressure and was reinforced by a temporary clay blanket.

The work was inevitably dangerous but was so well protected by the most complete improved safeguards that, although a very large number of "sand hogs," notoriously impatient of restrictions, were employed in very short shifts, all casualties due to the dangerous conditions were avoided. The satisfactory execution of the work, despite added war-time handicaps, is a notable achievement reflecting much credit on the officials, engineers and contractors responsible for it.

Interesting Contractors in Highway Work

A notice has been sent to road contractors in Montana by John N. Edy, chief engineer of the State Highway Commission of Montana, suggesting that a meeting of contractors be held in Helena "to afford an opportunity for contractors to familiarizing themselves with the program of construction proposed for 1920, and with the requirements of the specifications under which such improvements will be built." The recipients of the notice are requested to answer on an enclosed post card stating whether or not they will attend such a meeting if held before March 1st. If a sufficient number of favorable replies are received, such a meeting will be arranged for.

This seems like an excellent idea for interesting contractors in state highway work, and one worth considering by the highway departments of other states. It might be used, also, as an opportunity for receiving from the contractors suggestions for making changes in the specifications and contract which would make them more acceptable to the contractors without lessening their effectiveness in securing good work.

Since the above was written we have received a circular, dated January 29th, issued by C. C. Cottrell, state highway engineer of Nevada, inviting "contractors and prospective bidders on state highway work" to a meeting at Reno, on February 13th, in order that they may obtain a thorough understanding of everything pertaining to the construction of the state highways, "including the submission of bids, furnishing of bonds, inspection, interpretation of plans and specifications, progress payments and completion of work." Suggestions are asked from those who are now doing work for the state or who are about to bid upon it.

Such invitations as this may well be important steps towards that mutual understanding and co-operation between contractors and engineers which we have from time to time urged as important for the best interests of all parties concerned, including the tax payers.

Electric and Steam Power for Pumping Plants

This is the first of a series of articles in which managers and superintendents of water works plants will give facts and figures drawn from their experiences in operating both electric or internal combustion pumping units and steam pumping units in the same plant, illustrating the conditions under which each is the more satisfactory. In this instalment the plants at Elmira, N. Y., Dover, N. H., and Hagerstown, Md., are described.

During the past few years an increasing number of water works pumping plants have adopted electricity as a power, either supplanting or supplementing steam plants used previously. Information collected by this Journal about two years ago showed that at that time about twenty per cent of the eight hundred plants reporting had both electric and steam pumping machinery either in active service or in reserve.

The relative desirableness of the two types of plant depends upon first cost, cost of operation and upkeep, size of building required, reliability of operation, convenience of operation, and perhaps other considerations. The conditions as to each of these will vary in different cities, and the wisest decision in one case need not necessarily be the best in another.

Believing that a great many water works departments and companies are interested in the relative economy and general desirableness of these two types of plants, we have arranged to secure narratives of the experiences of a considerable number of superintendents and managers of water works plants where both kinds of machinery are installed. Our aim is to secure in each case such complete data and descriptions of the local conditions as will enable others to apply the facts, figures and conclusions to their own plants. One such article was given in the issue of Municipal Journal for March 1st, 1919—a description of the changing of the plant at Lancaster, Pa., from a steam plant to an electrical one, giving at considerable length the figures that formed the basis of the decision to make the change, and those taken later which justified that decision. We expect to publish a series of such statements at short intervals during the next few weeks or months, and present the first instalment herewith.

Elmira, N. Y.

Information concerning the Elmira, N. Y., municipal plant has been furnished by H. M. Beardsley, the general manager for the Water Board. Mr. Beardsley's statement is as follows:

The first operation of a pumping unit by electricity in our pumping station came about while the plant was privately owned and was for the purpose of aiding the electric department rather than the water department. The Elmira Water, Light & Railroad Co. owned and operated the water works plant, the gas plant, the electric power plant and the street railroad system of this city. The water department was doing better financially than any of the other departments and when the development of electric energy for power purposes began, some ten

years ago, it was seen that the load on the power lines of our pump station, which could be controlled by the power plant and not operated on peak load hours, would benefit the electric station immensely by filling in the valleys in the night load and mid-day load. The use of water at that time was about five and a half million gallons per day. A seven and a half million gallon motor-driven pump was purchased and installed and power was furnished by the electric department to the water department at station cost. The pump was a 2,300 volt pump, which was the station voltage, and no additions were made to the station cost for distribution, maintenance or general overhead expense. By this means the cost was reduced enough so as not to militate very greatly against the water works operation.

The plant being privately owned, the engineers and firemen could work twelve hours per day. Under electric operation the work was not heavy and two men, each working twelve hours, could handle the pump station. Even so, the pumping costs were a little higher under electric operation than under steam operation.

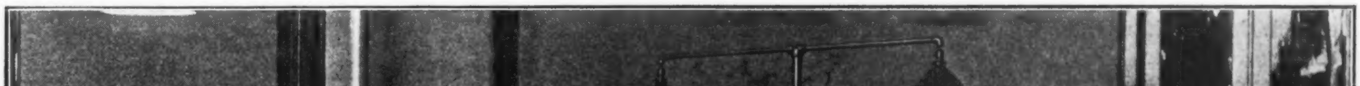
MUNICIPAL OPERATION.

On May 1st, 1915, the plant became a municipal plant through purchase by the city of Elmira, and the question of costs of power came to the front immediately. The plant was equipped with a ten-million-gallon Worthington steam pump installed in 1899 and a two-stage Worthington electrically-driven pump installed about 1908.

Just here let me say that we have two sources of supply. We have a four mile square water-shed, the water from which is impounded in a hundred-million-gallon reservoir, which furnishes us from 35 to 50 per cent of our entire supply by gravity to our filtration plant. Whatever is needed besides this is pumped from the Chemung river by the above-mentioned pumping plant, through about 9,000 feet of 24-inch pipe, against a total head, including suction and friction, of about 150 feet. This dual supply prevents long continued runs on our pumping plant because whenever the storage supply is sufficient its use is always given preference, because of both the quality of the water and the saving in operating costs.

To go back again to the question of operation. For the first few months after the purchase of the plant, the pump station continued to be operated electrically, following the practise by the private company, because we had made a very satisfactory contract with the private company which permitted, among other things, the use of current from 9 p. m. to 6 a. m. at one cent per kilowatt hour.

For the month of June, 1915, we used a little water from the storage reservoir but pumped 138,420,000 gallons, using 115,850 kilowatts or .837 kilowatt per thousand gallons. Total cost including labor was 1.15c per thousand gallons. During July and August we used from the storage reservoir. In September we pumped 116,610,000 gallons using 93,730 kilowatts or .804 kilowatt per thousand gallons and the total cost was 1.06c per thousand gallons. In November it was determined to use the steam unit, as it was estimated that the cost of pumping would be much less. Coal was then costing us $2.30 per net ton, plus 40c per ton for hauling and delivery. In November, 1915, 156 tons of coal were used to pump 112,130,000 gallons. Total cost of pumping, including labor, was .77c per thousand gallons. In December coal was 15c a ton higher and we use 151 tons to pump 104,720,000 gallons. Total pumping cost, including labor, .87c per thousand gallons.



New Steam Unit at Elmira, N. Y., Water Works Pumping Plant.

The labor crew was three engineers and three firemen working in three shifts of eight hours each, as required by state law for municipal plants. Fifteen to eighteen hours of pumping were necessary every day to keep up the supply.

THE NEW PLANT.

During 1916-1917, both pumping units named above, having outlived their usefulness, a new steam unit and a new electric unit were installed. No change was made in our boilers, as we have two Edgemoor water tube boilers of 250-horse-power capacity, each, either one of which could furnish ample steam for our purposes.

We installed a 260-horse-power Kerr multi-pressure-stage, horizontal steam turbine operating at a normal speed of 5,000 r.p.m. This was connected through a flexible coupling to a set of herringbone reducing gears for reducing the speed to the required pump speed. The pump was a seven and a half million gallon Allis-Chalmers centrifugal pump. The condenser was a C. H. Wheeler waterworks type.

For the electric unit we installed an Allis-Chalmers 12-inch double suction, single stage, horizontal shaft centrifugal pump, direct connected to one300-horse-power, 1,170 r.p.m., 2,200-volt, 60-cycle three-phase induction motor.

The costs of these two units, including all expenses of installation, inspection and tests, were $8,466.69 for the steam unit and $3,124.83 for the electric unit.

RELATIVE COSTS OF OPERATION.

Water was so plentiful in our storage reservoir that it was not necessary, until February, 1918, for anything more than trial tests to be run with the steam unit. In that month we used 90 tons of coal to pump 83,110,000 gallons of water; total cost of pumping, including labor, being 1.03c per thousand gallons. Coal at that time was costing $4.42 per net ton, including hauling. Labor rates then having a considerable advance and coal becoming scarce and higher priced, we found that steam cost was going considerably higher than would be the cost for electrical operation under our contract, which was still in force. During March and April of that year storage water was used almost entirely. In May, 82,670 kilowatts were used to pump 124,000,000 gallons. This, it will be noted, was with the new pumping unit and was .657 kilowatt per thousand gallons as against over .80 kilowatt with the old unit. The total cost for that month, including labor, was 1.02c per thousand gallons. We had then, of course, discharged our three firemen and the labor cost included only three engineers, working eight hours each.

That the electric unit has continued to function with the same efficiency is shown by the figures for December, 1919, the last month for which figures are available. During that month 74,050 kilowatts were used for pumping 112,400,000 gallons, or .66 kilowatt per thousand gallons. On account of the advance in labor, however, three men now cost the same as six men did in 1915. The total cost of pumping was 1.18c per thousand gallons.

These figures give a very good comparison of our pumping costs by the different operations. It will be noted that in actual operation steam cost is much less than electrical cost, even though we have a night rate of one cent per kilowatt hour.

Other costs, of course, must be included; but in the case of an old enterprise already possessing lands and buildings which carry a certain fixed over-head, I cannot see that such values should enter into the decision as between an electric and steam unit. If a brand new plant were being erected, of course, many such items should be taken into consideration. As a matter of fact, however, the steam turbine has cut down the required floor space so nearly to that of the electric unit that the extra room needed for steam apparatus as against electric apparatus is just the room necessary for the boilers and for storage of coal.

As regards reliability of operation, we have no fault to find with either. Our experiences with both have been eminently satisfactory.

While our experience with actual cost of operation is so much in favor of steam, yet we feel that electricity must have credited to it some things which warrant us in paying a little more for electric current than our steam operation cost. The chief factor is the flexibility of operation. We get so much water from storage that there are times, of course, when we do not need any pumping station at all. If we were operating with steam, which would require six men on our pay-roll all the time, there would be about 150 days a year when there would be practically nothing for the men to do. If, on the other hand, we had to operate our pump station continuously or (if not continuously for the twenty-four hours) if we had to operate it several hours *every* day, we should undoubtedly operate with steam as a matter of saving in expense.

Dover, N. H.

The facts and figures for the Dover, N .H., municipal plant have been furnished by Henry E. Perry, the superintendent. He states that the pumping station is of brick 30 x 36 feet in dimension, with a boiler room of the same size and a frame coal shed 25 x 45 feet. The steam pumping plant was erected in 1888 at a cost of $10,640, the building having cost $7,300. The steam pumping outfit consists of one George F. Blake compound duplex pumping engine with a capacity of 2,000,000 gallons in twenty-four hours, with jet condenser, boiler, etc.

In 1913 the city put in a 2,500,000 gallon De Laval centrifugal two-stage pump, direct connected to a General Electric 550-volt, 3-phase, 60-cycle, 1,750 r.p.m., squirrel-cage induction motor with standard compensator, transformer, etc., the whole costing $2,500.

The steam unit occupies the boiler room referred to and a space of 15 x 36 feet in the pump room. The electric pump and the motor occupy a space of about 10 x 15 feet in one corner of the pump room. There is still space in the pump room for three more elcetric units of the same type.

Figures for cost of operation show that to pump 1,000,000 gallons cost $28.54 with the steam unit and $25.90 with electricity. Water is pumped through 2,690 feet of 16-inch pipe to a reservoir against a dynamic head of 185 feet.

Reliability of Operation—we have been very fortunate as to stoppages of either steam or electric unit on account of mechanical troubles, coal shortage, strikes, lightning, or other causes. Neither plant has been stopped for more than three days altogether since the plants were installed.

Convenience.—The electric outfit has to us one great advantage over steam, in that, immediately upon throwing on the switch, the pressure rises, while with steam it takes about one hour at starting to get normal pressure and nearly that length of time to work the steam down at stopping. In addition, the electric unit has caused no trouble or annoyance to neighbors from noise or smoke, as is the case with steam.

Our purpose in installing the electric unit was that we might have two kinds of power so that, in case of the failure of one, we would have the other available. We have found these two to make an ideal combination.

Hagerstown, Md.

The manager of the municipal water works of Hagerstown, Md., Albert Heard, gives the following description of the plant in that city:

The Water Department of this city receives the bulk of its water supply by gravity from mountain reservoirs, but in the extremely dry periods for some years past has been compelled to use the Antietam creek as an auxiliary supply, and in 1902 built a pumping and filtration plant on this stream very close to the pipe lines carrying water from the mountain.

At the time of the building of this plant, electric power was very high and a considerable distance away, and we therefore used steam power from 1902 to 1915. By the latter date our consumption had increased to such an extent that our pumping facilities were inadequate, and after considering the cost of coal and the delivery of the same from a distance of two miles by wagons, we decided to increase our facilities by the use of electric power, which we have used for all our operations since 1915.

At the time of building the steam plant in 1902, the Washington County Water Company was the owner of the water works, having started the works in 1881. This ownership continued until June, 1918, when the city purchased the property and it is now a municipal plant.

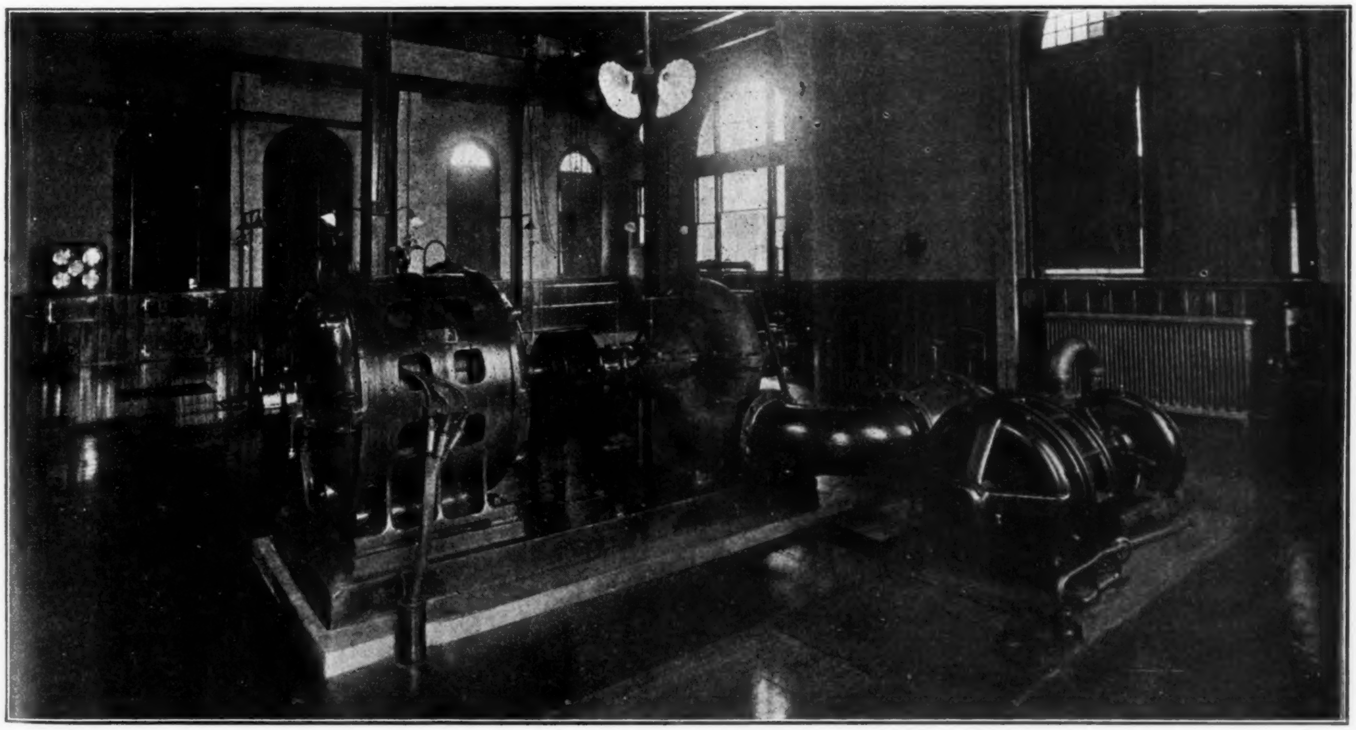
My experience has proven to my satisfaction that, as an auxiliary proposition, electricity at a reasonable price is the ideal power both as to cost and convenience, and I would hesitate to go back to steam unless it were for constant use with large equipment, and then only for efficiency, as electric power is far ahead of steam as to quickness and cleanliness.

Either of our plants can be started in 15 minutes, and with the slip ring motors which we use we can vary both pressure and quantity.

Pennsylvania Leads in Road Work

From information received by the Pennsylvania State Highway Department, it appears that state led all the others in 1919 in the total mileage of contracts let for road construction. During the year that department awarded contracts for building 679.26 miles of durable highways. Its next competitor was Illinois, which contracted for 510.70 miles. Ohio was third with 316.68 miles, followed by California, Oregon, West Virginia, Washington, Kansas, Massachusetts and Missouri in the order named. None of the others contracted for more than 100 miles. Only three—Wyoming, Iowa and Nevada—contracted for less than 10 miles.

It is claimed by the department that Pennsylvania not only contracted for, but built more miles of modern-type highways than any other state in the Union.



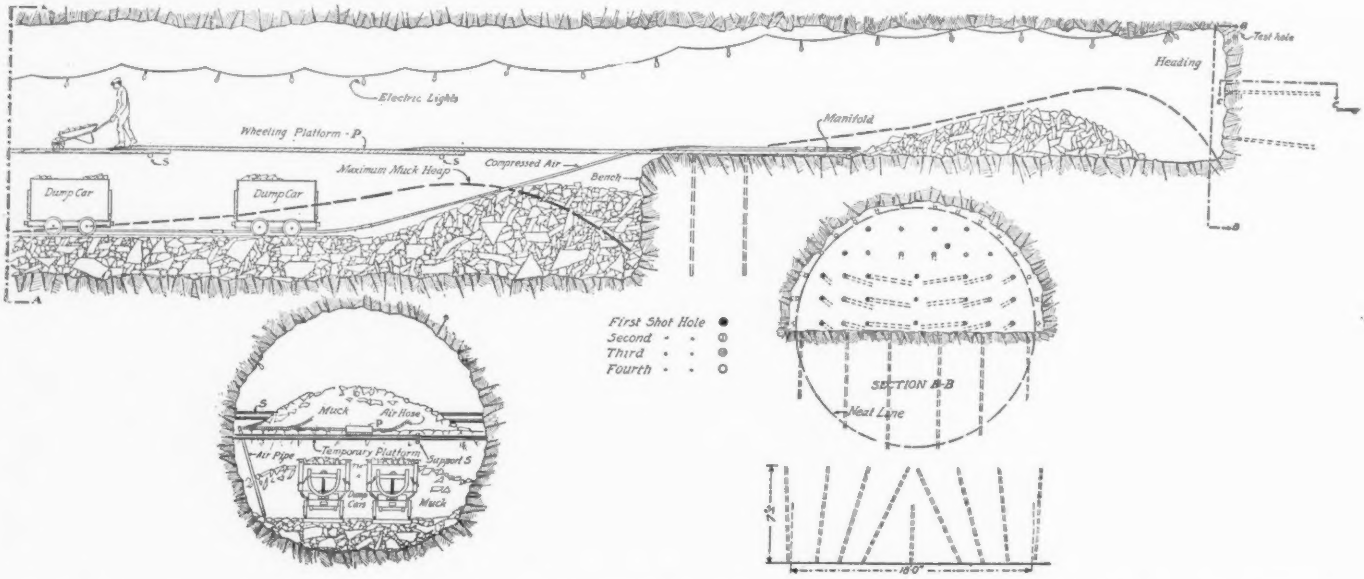
NEW ELECTRIC UNIT AT ELMIRA, N. Y., WATER WORKS PUMPING PLANT.
The pump in the right foreground is a small sump pump, given undue prominence by the photographic distortion.

Fourteenth Street Tunnel, New York

Nearly three miles of single track tunnels costing about six million dollars, driven under the East River, New York, to connect the subways in the boroughs of Manhattan and Brooklyn. About one hundred and twenty thousand yards of earth excavated under maximum air pressure of 38 pounds by use of eight one-hundred-ton steel shields, each advanced by hydraulic jacks capable of exerting four million pounds thrust. The shields, in sets of four, were assembled in steel-lined shore shafts, which were afterwards closed above the shields, the latter driven through openings in the walls of the shaft bulkheads built closing the tunnels behind the shields, and the shafts opened to atmospheric pressure. Where the tops of the tunnels are above the original river bottom the shields were driven through and under a blanket of clay forming an artificial roof thirty feet thick. About seventy thousand yards of rock were excavated under atmospheric pressure.

One of the lines of the New York Rapid Transit Subway system crosses under the East river at the foot of Fourteenth street, Manhattan, in two single track tubes about 30 feet apart on centers that are 3,435 feet long between shafts and extend beyond the shafts on both sides of the river to provide a total length of 14,178 feet of single track tunnels. Two land headings were also driven through soft ground under compressed air, 1,627 feet landward from the Manhattan shaft and 2,025 feet landward from the Brooklyn shaft.

For a distance of about 1,000 feet under the center of the channel where the tunnels pass entirely through rock, the cylindrical cast iron lining is 17 feet 2 inches in exterior diameter, and the sections of the segments have 7-inch flanges and webs one inch thick. For a distance of 560 feet in each tunnel the cast iron lining will be omitted, and the concrete lining will be built directly against the rock excavation. For the remainder of the tunnel, which was driven by the shield method, the cylinder is 18 feet in exterior diameter and the segments have 9-inch flanges and 1⅜-inch webs. The tunnel will be lined with concrete for its full length, the thickness of the concrete varying so that the inside diameter will be 15 feet for a length of 560 feet where there are no rings and will be 15 feet 6 inches for the light and heavy rings respectively.



Longitudinal and Cross Sections of Rock Tunnel, Showing Locations of Drill Holes and Method of Drilling and Handling the Muck on Invert an d Bench.

The tunnels have a maximum grade of 3.22 per cent. There is one 30,000-gallon sump and a pumping chamber under the middle of the river and the tubes are connected at several points by transverse passages. The principal quantities involved include about 120,000 yards of earth excavation, 70,000 yards of rock excavation, 50,000 yards of concrete and 40,000 tons of iron lining. The work was designed and its construction is directed by the Engineering Department of the Transit Construction Commission, D. L. Turner, chief engineer, Robert Ridgway, engineer of subway construction and C. D. Drew, engineer in charge at the present time. The work was commenced under the direction of Alfred Craven, then chief engineer, Robert Ridgway, engineer of subway construction, and C. M. Holland, then tunnel engineer. The work was awarded to Booth & Flinn, Ltd., for a contract price of about $6,000,000 and was to have been finished in 27 calendar months, but the contractor has been unable to finish the work in that time due to war conditions.

INSTALLATION OF SHIELDS.

Each of the two tunnels has been excavated with four headings, two of them being simultaneously started in opposite directions from the feet of the double shafts on both sides of the river that were sunk by the pneumatic caisson process.

This required the installation of eight steel shields 18 feet 6 inches in diameter, that with their equipment weighed about 104 tons each and were manufactured by the American Bridge Co. Each shield was equipped with 17 Watson-Stillman hydraulic jacks with a maximum thrust of 125 tons each under 4,500 lb. per square inch pressure, which were operated by electrically driven hydraulic pumps in the power houses near the shafts.

After the shafts were sunk to the required depth and the bottoms were sealed with a heavy concrete floor the air pressure was released and the heavy plate girder and buckle plate roofs over the working chambers were removed. A shield was then assembled at the foot of each of the two shafts in each caisson, four shields in all, and the roofs were replaced at a higher elevation giving clearance below them for the operation of the shields. Air pressure was again applied, and the circular bulkheads in the shore and river walls of the caissons were removed, permitting the shield to be advanced through them on the center lines of the tunnels.

When the shields were sufficiently advanced, concrete bulkheads, 10 feet thick, each of them engaging 5 complete rings of the cast iron lining, were constructed in the rear of the shields, about 70 feet from the shafts, and in them were placed material locks, manlocks, an upper emergency lock, and the necessary pipes and conduits. Air pressure was then released in the shafts and the rocks removed, leaving the shafts open to the air. Then the remaining four shields were assembled on the cradles at the foot of each shaft, the roofs again placed over them, air pressure resumed, and the shields sent out through the caisson openings in directions opposite to those referred to the first four headings. Again the roofs were removed, this time permanently, after the shields had advanced 100 feet and concrete bulkheads built behind them.

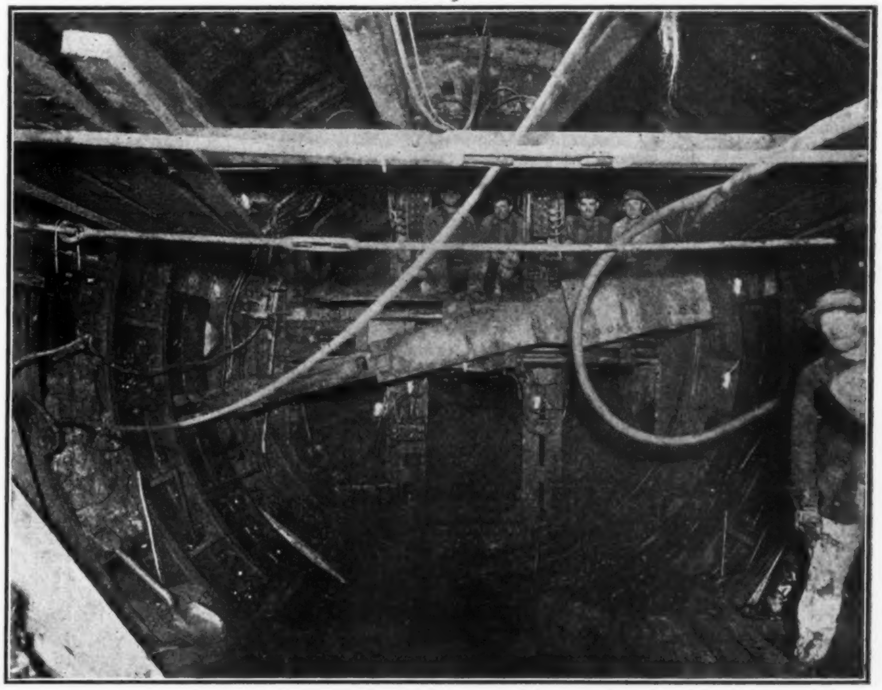
SHIELD EXCAVATION.

The shields were advanced in the usual manner under maximum air pressure of 38 lb. with which continuous operations were maintained by sixteen 1½-hour shifts daily. The shift for each heading consisted of 25 to 30 men who worked two shifts a day with 3-hour rest intervals between shifts. Great care was taken in the examination and direction of the men to see that no physically unfit laborers were employed, that they were properly cared for, and especially that sufficient time was taken in the decompression as they emerged from the tunnel. This was regulated by the lock tender who allowed the full time prescribed in the labor laws of New York State for the trip out. A 7x30-foot hospital lock was maintained on each side of the river with a competent nurse, and physician always in attendance, and all cases of the bends were so successfully treated that no serious injuries or fatalities resulted from them.

The shields advanced about 600 ft. to 800 ft. from the shafts, until they had penetrated their full length into solid rock, where they were finally stopped and were dismantled, the cylindrical shells remaining permanently in position. The iron lining was assembled inside of them and grouted solid on the exterior. The second set of bulkheads were then removed and the remainder of the excavation between headings in each tunnel was blasted in the usual way in free air.

SAFETY DIAPHRAGMS.

While the shields were being driven under air pressure transverse steel plate safety diaphragms about 6 ft.



View of Rear of Shield in Position, Showing Upper Platform Radial Arm for Erecting Heavy Lining Segments.

deep, were always maintained, bolted to the upper part of the segmental rings to form roof barriers sufficient to maintain air pockets in the event of the tunnels being flooded. These diaphragms were so arranged that the elevation of the bottom of the diaphragm was about 2 feet below elevation of top shield. An elevated gangway 3 feet wide with a hand rail on one side was maintained to the working face and between the diaphragms for the use of the men in case of emergency but fortunately was never needed.

SHIELD EXCAVATION.

The miners worked on a floor 2 feet above the bottom of the shield and on an upper platform, excavating in front and loading the muck in 1-yard dump cars hauled through the tunnel by 20-inch gage storage battery locomotives. In each shaft the muck cars were hoisted to about 20 feet above the surface of the ground and then run on elevated platform tracks to the dumping board established in the adjacent slip where they discharged their contents through hoppers to the barges moored alongside.

ROCK EXCAVATION.

After entering solid rock the drifts in each of the four headings were excavated under atmospheric pressure by the ordinary top heading and single bench method using two column drills in the heading and two jackhammers on the bench, all supplied with air from a high pressure pipe line carried on the invert and on the top of the bench and requiring in 24 hours from 34 to 48 men to fill the three shifts.

The drilling and mucking shift working from 8 a. m. to 4 p. m. commenced operations by removing any remainder of muck that obstructed the tunnel and drilled a total of 60 holes from 7 to 9 feet deep. The 47 holes in the top heading were inclined slightly from the horizontal as indicated in the diagram, and served to blow out a semi-circular cross-section approximately 20 feet in diameter, averaging 1 foot beyond the neat line to which payment was made for the excavation. Transverse rows of six vertical holes were drilled in the bench at intervals of 4 feet and the rock was shattered sufficiently to be loaded by hand into dump cars running on double track narrow gauge service lines laid on the invert and over the top of the muck pile to a point near the bench. The typical drill gang comprised four drill runners, four drill runners' helpers, two hand drill runners, two nippers, one mucker foreman, eight to ten muckers, one electrician and one pipe man.

BLASTING.

The blasting was done in four shots. The first shot consisting of three buster holes, from 4 to 7 feet long, on the vertical center line of the cross section, and 6 cut holes, 3 on each side of the center line, each of both sets of holes being loaded with eight 9-oz. sticks of 50 per cent gelatine dynamite. The first shot also included the first row of bench holes loaded with six sticks each.

The second shot included the second row of bench holes each loaded with six sticks of dynamite and ten holes in the heading of which the four reliever holes in the horizontal row just above the first-shot holes were each loaded with six sticks of dynamite and the three holes in the vertical rows each side of the first shot hole were each loaded with eight sticks of dynamite.

In the third shot one lower hole on each side of the heading was loaded with eight sticks of dynamite and the remaining holes, all of them reliever holes, were loaded with six sticks of dynamite each.

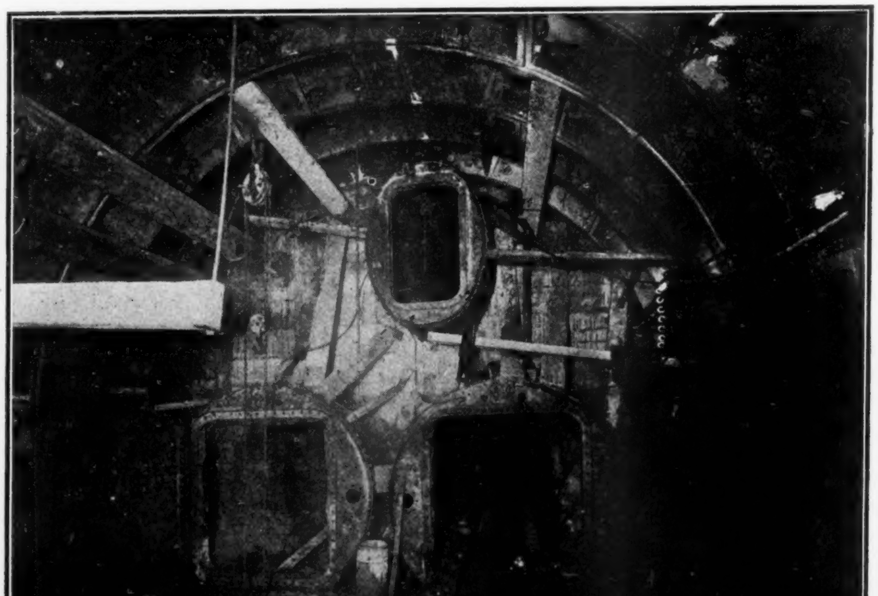
For the fourth shot the sixteen trimming holes outside the neat line of the tunnel section were loaded with different numbers of sticks of dynamite varying from eight sticks at the springing line to four sticks at the roof.

The 47 holes in the top heading and the bench required together an average of 225 lbs. of dynamite and required a blasting gang, consisting of 1 foreman and from 4 to 6 men who worked from 4 p. m., till 12 a. m.

PROGRESS OF WORK.

The average daily advance of the heading was 7 feet in three eight hour shifts, removing 11.06 yards of solid rock per linear foot, an amount which expanded from 60 to 75 per cent when broken.

As the work advanced, test holes about 9 feet long were drilled in the roof at an angle of 45 degrees, at intervals of about 14 feet, to determine in advance the presence of open seams in the rock, and at the springing line, horizontal telescopic pipe struts were set to carry a gangway at the level of the top of the bench, on which the muck from the bench was wheeled by hand and dumped into cars on the invert tracks. The mucking gang, consisting of 1 foreman, 8 to 14 muckers, 1 electrician, 1 pipe man, and 1 pump man worked from 12 a. m. to 8 a. m.



VIEW OF SECOND BULKHEAD.
Emergency air lock on top; suspended beam for safety platform at left.

ROOFS AND BLANKETS.

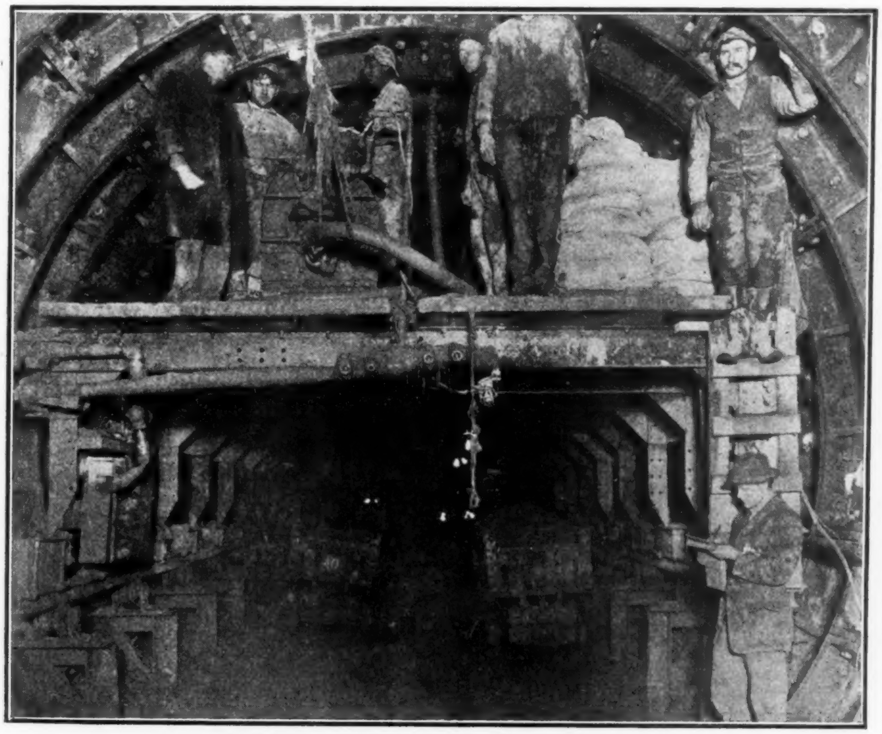
On the Brooklyn side of the river where the top of the tunnel is above the original bottom of the river, there was deposited a clay blanket 30 feet in maximum thickness and 125 feet wide, that covered both tunnels for a length of about 700 feet and contained about 100,000 yards of clay protected by rip-rap. It proved adequate to retain the air pressure and permitted the shields to be driven forward until they penetrated the inclined rock stratum.

In some places the rock roof over the tunnels was very thin with a minimum of about 4 feet of sound material overlaid by soft and decomposed rock. Here the excavation was carried on with extra care and very light charges of explosives were used. Every 10 feet the rock was sounded by the 45 degree test, holes drilled in the roof. The best record was made 220 linear feet for the river tunnels on the Manhattan side in January, 1918, and 275 linear feet for the land tunnels on the Manhattan side in March, 1918.

CONCRETE LINING.

On each side of the river there was installed a concrete plant equipped with a ½-yard electrically driven mixer and storage bins of 200 yard capacity for the premixed sand and graded gravel that were delivered on barges and unloaded by clamshell buckets. The aggregate was transferred from dump cars running on the overhead platform and emptying into the charging hopper, and the mixer installed in the upper part of the shaft. The mixer delivered through a 6-inch steel pipe to 1-yard dump cars in the bottoms of the shafts, that were hauled by the electric locomotives.

For the invert the concrete was dumped directly on the bottom of the cast iron lining, shoveled to place and screened to the required upper surface. These operations have been completed on the Manhattan side of the river and have been commenced on the Brooklyn side. The invert is to be followed by the building of the duct banks and concreting after which the remainder of the side walls and the arch will be concreted in 100 foot sections using Blaw steel forms shifted on carriages rolling on tracks. The approximate cost of the tunnel, including the shafts, is about $460 per linear foot of single-track tunnel.



VIEW IN TUNNEL AT SHAFT No. 4.
Shows trailing group platform in rear of shield with under clearance for muck cars. Grout pressure machine on upper deck.

Oregon Highway Engineers' Salaries

The Oregon Legislature has removed the limit of $5,000 per year for the salary of the state highway engineer, and is expected to pass, during the present session, a bill amending the salary limit of county surveyors throughout the state and providing that the salaries be fixed by the county commissioners. At present the pay is fixed at $5 a day.

Protecting a Machine-Excavated Pipe Trench

Trench for 30-in. drain pipe was excavated in very soft ground to a depth of 7 ft. by a No. 0 Austin Steam Trench Machine near Marengo, Ill. The ground was so bad that the sides of the trench would not hold up after the excavating machine had passed and the pipe was laid and jointed.

Protection for the pipe was provided by two sections of vertical wall about 12 ft. long, and 7 ft. high that were made of horizontal boards nailed to inside vertical cleats and spaced about 3 ft. apart, the normal width of the trench, by adjustable horizontal braces. A vertical frame was made fast to the forward end of these walls and braced to the trench machine, the latter being set with its buckets just even with the front of the walls.

The walls were attached to the machine that pulled them forward as it advanced, always maintaining them in the same relative position so that they served as a set of traveling sheeting advancing with the machine and protecting the sides of the trench from caving in immediately in the rear of the machine. Between these walls the pipe was laid and jointed and lightly covered as fast as the excavation was made. After the machine had passed and the pipe had been laid, the removal of the walls permitted the banks to cave in when it would no longer affect the work. With this apparatus contractor Monroe Farrar dug 1,200 ft. of trench per day with five men.

Nails for Concrete Forms

Doubledheaded nails having only one stem and two fixed heads about one-quarter inch apart have been found very convenient for fastening concrete forms that have to be stripped and re-assembled. The nails are driven in until the lower head engages, leaving the upper head projecting and this makes it convenient to be gripped by a claw and gently pulled out.

MINNETONKA BOULEVARD, BETWEEN MINNEAPOLIS AND LAKE MINNETONKA.
Length 11.8 miles; average width 22 feet. Received three hot applications of Texaco liquid asphalt No. 1, each ⅙ gallon per square yard, covered with sand and gravel. Work completed by Hennepin County Commissioners in August, 1919. Photograph taken October 3d.

Oiling Hennepin County Roads

By E. E. Terrell.*

Up to a few years ago we applied a light oil in the usual way to our roads, but apparently accomplished nothing but laying the dust for a few weeks and securing a miserably rough road which was very difficult to repair. The use of oil on roads applied in that way seemed anything but a success.

In analyzing the cause for oiled roads picking up in numerous places, thus leaving the surface very rough, I came to the conclusion that the trouble was due to dust or loose material **under** the oil, and that the remedy was to sweep the dust or loose material to the side and apply the oil to the clean, solid surface. I told Mr. Waddell, chairman of the Road and Bridge Committee of the County Board, my conclusions and he said to go ahead and try it out.

When we first tried it out, after oiling, we gathered the dust and loose material in from the side of the road with a blade grader and covered the oil. This treatment began to show results. When not enough material can be swept from the road to cover the oiled surface, we haul fresh, clean gravel along the sides for a covering. We always try to cover the surface immediately after applying the oil. We seldom apply oil, now, without covering it with sweepings or something better.

This past summer we scarified all our previously oiled roads as shallow as it was possible to do. After scarifying, the road was scraped with a large grader and well compacted with rollers. I consider the most favorable time to apply oil is immediately after the compacting, first sweeping all loose material from the surface; but we did not have the oil at that time, so had to apply it after the road had taken considerable traffic.

We had about three and one-half miles of broken stone macadam which had become so rough that traffic detoured to avoid it. This was scarified about two to two and one-half inches deep, put in shape with a "Giant" grader and the surface set by rolling. Seven-tenths of a gallon of about 70 per cent asphalt oil per square yard was then applied.

After the oil application the surface was covered with screened gravel ranging in size from pebbles retained on a quarter inch screen to pebbles passing a one-half inch screen, and then well rolled. This piece of road

*County surveyor of Hennepin county, Minnesota.

EXCELSIOR BOULEVARD, HENNEPIN COUNTY.
Three hot applications of ⅙ gallon each of Texaco liquid asphalt No. 1, covered with sand and gravel. Dirt road base. Completed August, 1919.

was almost like a pavement when completed and was in splendid condition when winter set in.

In the construction of oil roads, we use nothing but heavy asphalt oil, 65 to 80 per cent. I would like the lighter grade first on gravel roads, and after the surface has been well formed, the heavier grades are preferred.

Heating is an important part of the work. The oil should be heated as hot as it will bear without burning.

To name the different parts of the work of treating a road with oil, in order of their importance, I should like to say:

First, get a good, reliable grade of heavy asphalt oil.

Second, sweep the surface clean.

Third, cover the surface with pea rock, rock screenings or clean, coarse sand as soon after applying the oil as it is possible to put it on; and

Fourth, the surtace may be rolled after the covering is put on.

Paving an Arid, Rockless District

By Frank Reed

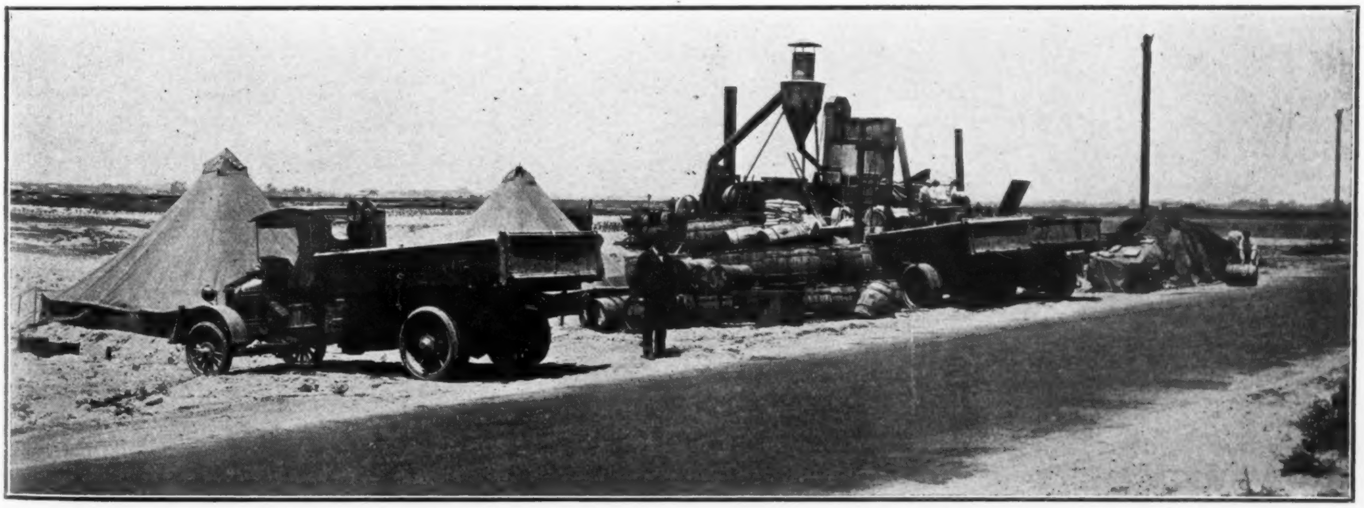
The absence of water was met by using asphalt as a binder; the absence and cost of rock, by using as an aggregate only dune sand, which was abundant alongside the road. Part of the stretch was laid on a fill across a slough, part on an old macadam pavement. Heavy traffic has been carried on this pavement for several months.

The city of Los Angeles, California, and the port of San Pedro are connected by Harbor Boulevard. Most of this highway has been paved with oil-bound macadam, but a fill across "Nigger Slough" has remained unpaved because it has settled each year, at the time of the spring rains, sometimes as much as three feet. This stretch was paved last summer.

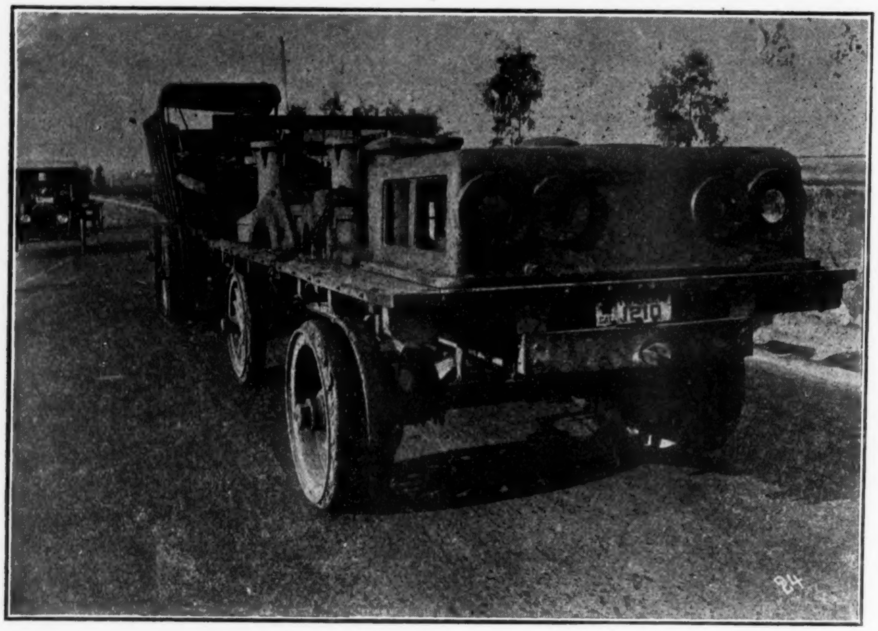
This highway carries a very heavy traffic as compared with most western roads. A traffic census taken by officials of Los Angeles county between July 1st and November 1st, 1919, showed a total of 502,583 automobiles, of which 59,783 were trucks. The vehicles averaged 4,086 per day and the average daily tonnage was 6,043. There is a large shipyard at the harbor, where several ships are constantly under construction, and the heavy steel for these is trucked over the boulevard. Figures are available of one heavy haulage unit consisting of a specially constructed trailer weighing 6 tons and carrying a load of 20 tons, drawn by two trucks, each weighing 6 tons and carrying a 7-ton load; a total weight of 52 tons.

Local conditions here, like those in a considerable part of the southwest, include absence of both water and rock, thus making excessive the cost of concrete for either base or finished pavement.

The pavement laid last summer included the fill across Nigger Slough and the surfacing of some old macadam, totaling approximately a mile in length. The material used was that known as "Willite," which used as the sole aggregate the light, drifting sand, a trifle loamy,



Mixing Plant; Old Oil-bound Macadam Section of Boulevard.



Machinery on Truck and Trailer on Harbor Boulevard.

found along the highway, and a binder of asphalt treated with copper sulphate, this binder being the special feature of this kind of pavement. The dune sand used was subjected to sieve analysis, with the following result:

Passing 200-mesh	6 per cent
Passing 100-mesh and retained on 200	48 per cent
Passing 80-mesh and retained on 100	28 per cent
Passing 60-mesh and retained on 80	14 per cent
Passing 40-mesh and retained on 60	3.5 per cent
Passing 20-mesh and retained on 40	1.0 per cent
Retained on 20-mesh	0.0 per cent
	100.5 per cent

No broken stone was used, and the only water used was for the steam boilers of the road roller and asphalt plant and for the men and animals on the job. The mixture consisted of the following, for a 747-pound box:

Sand	650 pounds
Asphalt	75 pounds
Limestone dust	20 pounds
Sulphate	2 pounds
	747 pounds

No hauling was required for 87 per cent of the material, the sand being dragged to the mixing plant from the dunes near by by means of Fresno scrapers. The cost of the mineral aggregate, delivered in the mixer, was figured by the contractor's cost accountant at less than 40 cents a cubic yard.

The pavement was made 5 inches thick where laid directly on the dirt surface of the unpaved road, and a 2-inch surfacing was laid on the old macadam.

METHOD OF CONSTRUCTION.

The mixing plant is only slightly modified from the familiar asphalt plant. The mixing bucket is somewhat larger, to admit of the effervescence which takes place when the copper sulphate is added to the heated asphalt. The heated asphalt is delivered by force pump, the sand is handled by automatic conveyor, and delivery to truck is made automatically on completion of the mix by opening the bottom of the pug mixer. The material was loaded onto the trucks at about 320 deg. F.

On this job, after the hot material had been spread, all rolling took place lengthwise of the highway, it being impossible to undertake the customary cross-rolling on account of the pavement extending close to the sides of the fill.

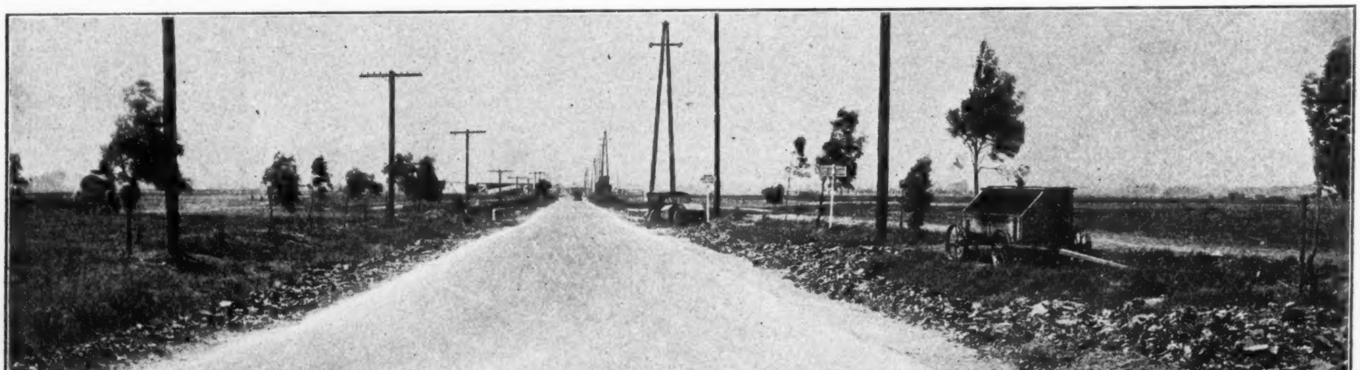
In the 5-inch section on dirt, as this thickness could not be rolled at a single operation, the job was done in two layers, a 3-inch base, with a 2-inch covering.

The 2-inch pavement laid over an old macadam foundation was placed after the top of the old road had been scarified and a 12-ton roller used for leveling and scraping.

This paving was begun May 28th and completed July 1st. It was opened to traffic a few hours after completion.

SERVICE GIVEN.

Since its completion the pavement has received a daily



Two-inch Pavement on Old Macadam After Several Months Use.

connection pounding by the heavy traffic described above. The traffic is carried at the full rate of speed of the vehicle, and as it is continuous and the pavement is only 20 feet wide and vehicles pass each other at very close intervals of time, the drivers practically follow in a track, so that wheel impact is not very much distributed over the surface.

This pavement has several times been subjected to extreme stresses of heavy combination truck and trailer loads. There has been a great deal of movement of lumber and other heavy commodities over it, and all of these commodities are commonly hauled with truck and trailer, or truck and two trailers.

At the present time the pavement shows no signs whatever of any cracks and it has withstood the effects of traffic during the extreme summer heat of southern California without rutting or waving. In fact, one of the claims made for Willite is that it sets so firm that it is not affected by heat, the effect of sulphate treatment being to lower the penetration of the completed pavement without increasing brittleness.

About twelve days after the completion of the work some slipping was noted between the upper and lower courses. An inspection showed that the failure to properly bond was due to dust which had drifted onto the completed lower course before the top 2 inches had been applied. Accordingly it was determined to remove as much of the 2-inch upper course as could be pried off with crowbars, and resurface after first treating the exposed surface of the 3-inch base to insure bond. This was done by roughening with picks and applying a "paint coat," after which a new 2-inch surface was immediately spread and rolled.

Since the original completion of the job there has been no indication of any separation from its base of the 2-inch surface laid over the old macadam foundation; nor has the relaid 2-inch top course in the 5-inch pavement shown any signs of trouble.

Sewage Filters from Refuse*

By W. Scouller, M.Sc., A.I.C.†

A bank of refuse, dumped as a fill in Chester, England, was leveled off and used as a sewage filter, with such success that the corporation expects to greatly extend their use of such material. Leek, England, has been practicing the same method for sixteen years. The chemical effect of the treatment is described.

House refuse has been disposed of at Chester for many years by raising low-lying land 10 feet and covering with a top layer of 6 inches of soil. About six years ago the height of the refuse was reduced to 4½ feet, and the top layer of soil and subsoil increased to 18 inches, and good crops have been obtained by this method. In 1904 four acres of land on the sewage works site were covered with house refuse 10 feet high, with the intention of building storm water filters thereon. In 1910 a scheme of sewage works extensions was got out, which included the building of filters on this house refuse area. The cost was found to be heavy, and after alternative schemes had been drawn up and discussed, I decided to try the effect of direct filtration through the refuse bank. A section of the bank was accordingly dug out and placed in an experimental filter, 3 feet in diameter and 7 feet 6 inches deep. The refuse was ten years old, and consisted of ashes, bottles, crockery, bones, iron cans and general garbage. The filter was started in January, 1914, and treated crude sewage at the rate of 100,000 gallons per acre per day. On March 7th, 1914, the rate of treatment was increased to 200,000 gallons of crude sewage per acre per day. The resulting effluent was of most excellent quality. The free ammonia almost entirely disappeared, and the nitrate was large. The rate of disappearance of dissolved oxygen in five days was small. The permanent hardness, however, was very high, and was mainly due to the solution of $CaSO_4$ from the refuse. An estimation of $CaSO_4$ in the refuse used was not made, but over half a ton of this substance was dissolved out of the refuse per 100,000 gallons of sewage treated.

The analytical results are as follows:—

Analysis of Experimental Refuse Bank Effluent

Parts per 100,000	Crude sewage	Effluent Feb. 1914*	Effluent Mar. 1914†	Effluent Apr. 1914†
Free and saline nitrogen	2.86	0.012	0.005	0.005
Albuminoid nitrogen	0.867	0.029	0.022	0.018
Nitric nitrogen	....	3.1	5.0	4.8
Oxygen absorbed in 4 hrs. at 80° F.	11.68	0.38	0.40	0.40
Disappearance of dissolved oxygen in 5 days at 18.3° C.	....	0.20	0.07	0.06
Hardness, temporary	....	8.0	....	....
Hardness, permanent	....	162.0	....	....

* 100,000 gallons per acre per twenty-four hours.
† 200,000 gallons per acre per twenty-four hours.

In May, 1914, the experimental filter having proved so successful, half an acre of the refuse bank was

*From "Municipal Engineering and the Sanitary Record" (England).
†Chemist and Manager of the Chester Corporation Sewage Works.

prepared and tank effluent distributed over it at the rate of 150,000 gallons per acre per day. The bank is not underdrained, and a well was sunk in it to enable a sample of the effluent to be collected at a depth of 4 feet. The results were excellent and confirmed the experimental filter. The analytical results are as follows:—

Analysis of Refuse Bank Half-Acre Filter

Parts per 100,000	June, 1914	August, 1914
Free and saline nitrogen.........	....	0.024
Albuminoid nitrogen............	....	0.029
Nitric nitrogen	1.3	2.86
Oxygen absorbed in 4 hrs. at 80° F.	0.58	0.66
Disappearance of dissolved oxygen in 5 days at 18.3° C.........	0.15	0.19

It now became necessary to know if fresh town refuse could be used for filtering sewage. The experimental filter was therefore emptied and refilled with house refuse fresh from the city in January, 1917. The weather was very frosty, but in six days nitrates appeared in the effluent, and in sixteen days the effluent was of good quality. These results were very surprising, when one considers that the refuse consisted of ashes, rags, old boots, bottles, bones, crockery, tin cans, etc. The filter, in fact, gave similar results to the old refuse filter, and is doing so to the present day. The average results of a number of analyses are as follows:—

Fresh Town Refuse Experimental Filter

Parts per 100,000	October, 1917
Free and saline nitrogen.........................	Trace
Albuminoid nitrogen............................	0.032
Nitric nitrogen	3.8
Oxygen absorbed in 4 hrs. at 80° F.............	0.41

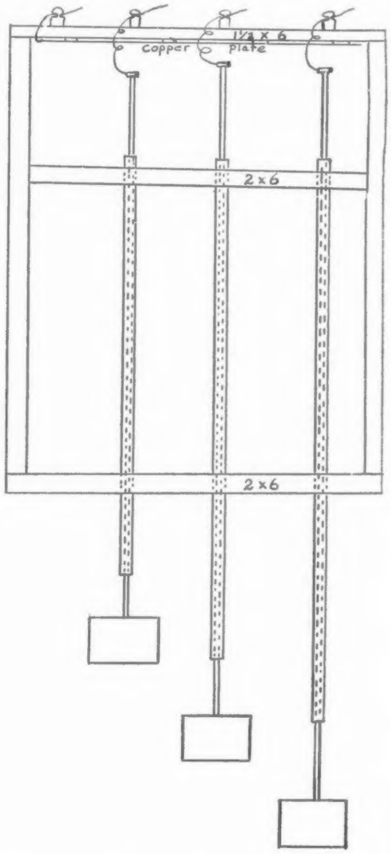
The scheme for using house refuse for sewage filters is briefly as follows:—The land will be underdrained and the refuse raised 10 feet with a top layer of soil 6 inches deep to act as a distributing layer for the sewage tank effluent. The present method of adding 18 inches of soil to the top of 4 feet 6 inches of refuse will be discontinued, as it would considerably lower the rate of treatment, and, in fact, make it into a land filter. Incidentally, the change-over will save the labor of four men at the tip.

Note: The Chester Corporation has applied to the Ministry of Health for approval of a loan of $90,000 for purchase of land for extending the method of sewage treatment. After this article was written it was learned that Leek, England, had been practicing the same method for sixteen years.

RESERVOIR WATER-LEVEL GAUGE.

Having seen the description in our issue of November 29, 1919, of a gauge by which the engineer at the pumping station can tell the height of water in the reservoir, C. M. Hooper, superintendent of the water department of Pullman, Wash., sends us a description of one of an entirely different kind which he installed in the reservoir of that city in 1914 and which he says has worked perfectly.

The appliance consists of a rectangular frame 4 feet wide by 5 feet high made of 2x6 timbers. In this are set, in a vertical position, three 1-inch gas pipes (or as many more as may be necessary) inside of each of which pipes is passed a round stick of wood of such size as to move freely, each stick carrying at the bottom a float and at the top a piece of brass. A copper plate two or three inches wide and about three feet six inches long is fastened under the upper timber of the frame, but insulated from it. On top of the same timber are four insulators. To each piece of brass on the top ends of the sticks above referred to is fastened a wire, which is carried to the pumping station and there connected to an electric light signal, to be described. Each wire is attached to one of the insulators on top of the frame, with a loop between this and the brass tip referred to, to permit several inches' vertical



RESERVOIR WATER-LEVEL INDICATOR.

motion in the rod. A fourth wire is attached to the copper plate and, first being fastened around the fourth insulator, is also carried to the pumping station.

Each of the rods referred to is provided with a pin which prevents the brass tip from dropping more than two or three inches below the copper plate. The rods extend to different depths. As the water rises to the float on the longest rod, it raises this until there is contact between the brass tip and the copper plate, which of course closes the circuit. This remains closed until the water again falls below the float. If the water rises to the second float, this in turn forms a contact, and similarly with the third float.

In the office at the pumping plant there are three electric lights connected respectively to the wires from the three floats, so that, as the water raises each float to complete the circuit, the corresponding light is switched on. The reservoir referred to is one mile from the plant and the wires are carried between the two on the standard poles and cross-arms used in connection with the city lighting system.

Cost of Horse Maintenance

Itemized costs as reported by ten cities are analyzed, estimates made of values for depreciation, insurance and other charges, allowance made for days horses are not working, and a charge for team and driver of $8 to $10 a day considered proper.

Like everything else, the cost of keeping horses and mules has risen during the past few years. The figures of two or three or four years ago are of little use now as a standard for estimating equine expenses; in fact there are no figures really available. In the past, a main reliance has been upon the reports of those departments of the larger cities where horses or mules in considerable number are kept. But, unfortunately, the vast majority of municipal reports are from six to twele months late in appearing, which makes the data contained in them more valuable for record than for use. These reports, however, are practically the only place where such figures can be found, and an attempt will be made to present such data as may have value and to arrange it so that by taking into account local conditions and prices, a reasonable estimate can be made.

Of the expense of keeping such animals as horses and mules, approximately two-thirds will ordinarily represent the cost of feed, such as hay, oats, etc. (That this does not always hold is evidenced by the Boston and Cincinnati costs given later.) The remainder is taken up by the direct labor cost of caring for the animals and by the overhead, such as maintaining the stables, etc. The cost of replacing worn-out horses—depreciation—is taken into account by only one city (Rochester, N. Y., in a recent report), though it ought to be by all; and the same is true of interest on the first cost and insurance. In arriving at any accurate estimate of the actual cost of the horse per day, these figures should be included, as should the number of days the horse actually works. Probably there are few muncipal horses that work more than 260 days in a year, though they have to be maintained for 365 days.

The average rations for horses employed in the street departments of several cities are given below. This may be assumed as the standard for animals on heavy work. It is quite the usual custom to halve the oat ration when not actually working. All rations are given in pounds per day.

City	Hay	Oats	Other Feed	Straw
Rochester	22	11		
New York	18	23	3½ (bran)	3
Chicago	20	10	¾ (bran)	1/10 bbl. shavings
Columbus (1915)	31	12¾		6 1/3
Columbus (1916)	30	12		5 1/3
Cincinnati (1917)	16	11.8	3 (nutritia)	
Cincinnati (1918)	15.8	12.2	3.1 "	
Washington (1915)	14		1.7 (bran)	3 1/3

These figures indicate an average ration of 20.8 pounds of hay, 13 pounds of oats and 2 pounds, more or less, of other feed, with about 5 pounds of straw for bedding. By taking into account local prices, it is possible to figure, with a fair degree of accuracy, the cost of feed.

For purposes of comparison, figures will be given for various cities, which have been selected with a view of showing the rise in costs, and also of covering the country fairly well.

FIGURES FROM ELEVEN CITIES.

Washington, D. C., year ending June 30, 1919. Costs on 51 horses and 32 mules show a feed cost of $21.94 per month and a cost of shoeing of $1.35 monthly. No account taken of labor, replacements, interest, or maintenance.

St. Louis, Mo., year ending April, 1918. Costs $263.06 per year per horse or mule. Figures monthly are as follows: Feed, $14.75; shoeing, $2.84; labor $4.33; total, $21.92. No other items included. Costs for previous year were $12.19, labor included, per month.

Savannah, Ga., year ending Dec. 31, 1917, cost for feeding alone was $14.50.

Boston, Mass., year ending Jan. 31, 1918, costs for 29 horses in sewer department were $1,638 per day, made up as follows: Labor, 76.7 cents; hay and grain, 67.1 cents; shoeing 15.1 cents; veterinary services, medicine and clipping, 3.2 cents; stable goods, 1.78 cents.

Horses in Boston.

Costs for Sanitary Department, 1917-18. Cost per Horse per Day on a Basis of 365 Days per Year.

Districts.	South Boston.	East Boston.	Charles-town.	Dor-chester.	Rox-bury.	South Stable.	West Stable.	Total.
Average No. of Horses Kept.	20.26	15.6	12.06	14.4	19.4	64	32.1	177.95
Labor	$0.6282	$0.5479	$0.6609	$0.746	$0.4534	$0.5699	$0.4708	$0.5521
Hay and grain.....	0.6053	0.7033	0.7307	0.547	0.7179	0.7322	0.744	7052
Fuel	0.0179	0.0071	0.0156	0.0863	0.0057	0.0005	.....	0.0076
Light	0.0079	0.0106	0.0125	0.0096	0.0302	.....	.....	0.0067
Rent and taxes.....	0.1217	0.4111	.....	.....	.....	.....	.....	0.0498
Yard and stable repairs.....	0.0277	.....	0.0556	0.0443	0.0468	0.0282	0.0224	0.0282
Yard and stable furnishing.....	0.0276	0.0159	0.0197	0.0304	0.0252	0.0453	0.0196	0.0309
Veterinary service and medicine....	0.0191	0.0179	0.0163	0.0007	0.0005	0.0003	0.0154	0.0058
Horseshoeing and clipping.....	0.14	0.1594	0.1692	0.0945	0.0897	0.1183	0.1124	0.1217
Totals	$1.6362	$1.8712	$1.6802	$1.5081	$1.3695	$1.9515	$1.3747	1.5067

Rochester, N. Y. In 1918, Rochester states the average cost of the hay ration per horse to be 38.7 cents and of the oat ration 32.7 cents per day. The cost for maintenance of all kinds was $1.17 per horse per day, or $458.01 for the year. For 1917, the annual cost was given as $336.65. The cost of shoeing in 1917 is set at 12 cents per day and the stable operating cost 21 cents.

Columbus, O. The cost per day per horse has increased from 83 cents per day in 1915 to $1.176 in 1918. Itemized costs for the four years are:

	1915	1916	1917	1918
Feeding and bedding	$0.4577	.4163	.5340	.6727
Labor, harness, supplies, veterinary	.2922	.3263	.3263	.3925
Shoeing, etc.	.0801	.0944	.1062	.1107
Total cost per day	.8300	.8370	.9665	1.1759

Cincinnati, O. Figures for the year 1918 show a cost close to that given by Columbus. For purposes of comparison, figures for the same four years are given.

	1915	1916	1917	1918
Cost per horse day for feed	$0.382	.349	.490	.633
Other stable expenses, per horse day	.368	.393	.411	.465
Cost of maintaining horse per day	.750	.742	.901	1.098
Horses idle, average, days per month, (excl. Sundays)	4.0	3.8	5.4	5.7
Cost of feed per days horse actually worked	.564	.515	.770	.982
Other stable expenses, horse days actually worked	.534	.579	.645	.728
Cost per horse day actually worked	1.098.	1.194	1.415	1.710

Charleston, S. C. The average cost per month in 1918 for keeping horses was $19.27, which included feed only. Hay during the year averaged $1.84 per hundred and oats $1.046 per bushel.

Brockton, Mass. Jan. 1, 1920, contractor who does much of the teaming work for the city estimates cost of keeping horses, exclusive of depreciation, interest, etc., at $37.50 per month, and the useful life of a horse at 8 years.

Hampton, Va. During the latter part of 1919, the cost of keeping one mule has run from $40 per month upward. In December, 1919, the cost for feed alone was $47.50. This mule is kept in a negro section in a flimsy barn and part of the grain is known to have been stolen.

Chicago, Ill. The ration fed Chicago horses has been given previously. The first cost of a horse runs from $200 to $250, and the useful life is estimated at from 6 to 8 years. Harness costs $100 and lasts 6 to 8 years. Shoeing costs $5 per month, and veterinary attention and medicine 10 cents per day.

CALCULATION OF TOTAL COST.

It will be noted that no city, excepting Cincinnati, makes any references to the actual number of days the animal works. Taking the average of the days the horses did not work, as shown in the four years, 1915, 1916, 1917 and 1918, in Cincinnati, as a standard, the average horse works only 256 days per year. Probably a great many horses work more than this, but the point is that the per diem maintenance figures based on 365 days must be increased, in this case by 35%, to take care of Sundays and idle days, when the horse must be fed.

A careful inspection of the foregoing costs also leads to the conclusion that the costs given by many of the cities are incomplete in regard to overhead, stable costs, etc. None of the cities, with the exception of Rochester, makes any estimate of depreciation and replacement of horses; and none at all makes any reference to interest on first cost. None refers to insurance. These three items are always considered in motor truck operating cost records, and are of equal importance here.

Rochester, from the following figures, estimates that the annual depreciation per horse is about $30 per year. The following figures show the annual expenditure necessary to maintain a stable of 65 horses.

COST OF HORSE RENEWALS—DEPRECIATION.

Year	Number of Horses	Spent for Renewals	Av. Cost per Horse Yearly
1912	65	$2219	$34
1913	65	1885	29
1914	65	4205	65
1915	66	1020	15
1916	66	1575	24
1917	68	1125	17
Average depreciation per horse per year	..	....	30.67

Allowing for the purchase of the 3 additional horses, bringing the number to 68, at a price of $275 each, the average cost of maintenance is $28.36 each. This is probably a little low. Another estimate given is as follows:

First Cost	$275	Average useful life 6 years.
Salable value	75	
Net cost	200	Average yearly cost $33.33

There may be some argument as to the useful life of a horse, and it may be contended that 6 years is too small an estimate. But with the rather generous salvage value given above, this seems fair.

Interest on a horse, taken at 5% on a value of $275, amounts to $13.50 per year. Insurance would also amount to an appreciable sum.

Averaging the costs of the three cities which seem to have the most complete records,—Boston, Columbus and Cincinnati—we have for upkeep the following figures:

ESTIMATED TOTAL COST PER DAY OF A HORSE.

Boston (1918)	$1.507
Columbus (1918)	1.176
Cincinnati (1918)	1.098
Average	1.26
35% for time lost	.44
Depreciation per working day	.12
Interest per working day	.05
Total daily cost	1.87

When the cost for maintaining a horse is $1.87 per day, the cost of 2 horses will be $3.74. Adding a driver at $3.00 and allowing 25 cents per day for the wagon, brings the actual cost to $6.99 per day.

Boston, in 1917-1918, hired teams in eleven dsitricts at an average of $3.04 per day for one-horse teams and $4.80 per day for two-horse teams. These teams were furnished by contract at the above prices. With driver at $2.75 per day, the single teams cost the city $5.79 and the double teams $7.55. St. Paul in 1918 paid 75 cents per hour. One city reports hiring teams at $4 per day, but goes on to remark that they were of unusually poor quality. This might have been expected, it seems.

A rather hasty view of the situation would seem to indicate that teams of the first quality will have to be paid $8, $9, or even in sections, $10 per day. With these prices naturally comes forward the question of the motor truck. Certainly, in view of these figures, there seems to be a still larger field of usefulness open to it.

LEGAL NOTES

A Summary and Notes of Recent Decisions—

Injunction Against Street Assessments.

(Neb.) While a city of the second class having more tnan 1,000 and less than 5,000 inhabitants cannot make a vaild contract for extensive street paving without the estimate required by Rev. St. 1913, § 5011, yet, where the city engineer was incompetent to make the estimate, and proper estimate was made by engineers employed by the city for that purpose, property owners cannot enjoin assessment of benefits after the paving is completed on the ground that the estimate was not made by the city engineer.—Diederich v. City of Red Cloud, 173 N. W. 698.

An assessment for street paving, contracted for by city of second class, cannot be enjoined because a street railway was allowed to remove its rails from the street to be paved instead of paving the space formerly occupied thereby, as required by Rev. St. 1913, §5110.—Id.

An assessment for street paving, contracted for by city of the second class, cannot be enjonied because the contractor guaranteed the quality of the work and to make good any defect found within five years.—Id.

An assessment for street paving, contracted for by a city of the second class, cannot be enjoined because no formal personal notice of the formation of the paving district was given property owners.—Id.

Control by City Over Street Uses—Vehicle Ordinance.

(Cal. App.) A charter, giving a city "plenary control over all uses of its streets," authorizes a traffic ordinance regulating the manner in which vehicle drivers should turn street corners.—Pemberton v. Arny, 183 P. 356.

Regulation of Excavations and Sidewalk Openings.

(Fla.) A city may regulate how excavation in the subsurface shall be made by the owner of the fee, and may regulate how trapdoors or other appliances for closing the opening shall be constructed, but may not arbitrarily refuse a permit nor place additional burdens upon the abutting owners under guise of regulation, so as to deprive him of his rights in the subsurface.—S. H. Kress & Co. v. City of Miami, 82 So. 775.

A city may require the owner of the fee in a street to procure a permit before making an opening in the sidewalk, and it may see that proper safeguards are used and that the rights of the public are not unreasonably interfered with.—Id.

Power to Regulate Load and Tire Width of Vehicles.

(Ohio) When a city has adopted a charter under which it is authorized to exercise all powers of local self-government pursuant to Const. art 18, §§ 3 and 7, the authority to locate, establish, and protect the streets within its limits resides in the municipality, and it may adopt and enforce such reasonable regulation as it deems proper.—Froelich v. City of Cleveland, 124 N. E. 212.

The state and municipalities may make all reasonable, necessary, and appropriate provisions to promote the health, morals, peace, and welfare of the community, but the means adopted must be suitable, impartial, and not unduly oppressive upon individuals, must have a real substantial relation to their purpose, and must not necessarily interfere with private rights.—Id.

Where a city has adopted a charter under which it is authorized to exercise the powers of self-government provided, for by Const. art. 18, §§ 3 and 7, it may regulate the weight of loads and width of tires of vehicles passing over its streets by virtue of the express authority conferred in the Constitution.—Id.

Street Cleaning Contract—Arbitration Clause.

(Pa.) Where a city's contract for street cleaning shows on its face that it was clearly intended to be an arbitration agreement, and an award of director of public works, as arbitrator, is set up in defense to a suit on the contract, a provision at conclusion of contract that no certificate of any city officer should bind the city will not be considered, being repugnent to the paramount intention of parties as to arbitration.—Curran v. City of Philadelphia, 107 A. 636.

Where a city street-cleaning contract contains an arbitration provision apparently so comprehensive as to include all disputes to be determined by engineer. and another arbitration provision limited to certain defined questions for determination by director, they may both stand, and matters specified in the second provision will be excepted from the more comprehensive first provision. —Id.

Where a street-cleaning contract, providing that the director of public works should pass on deductions for certain defaults, did not provide for ex parte hearings by him, his function was judicial, and it was his duty to afford the contractor an opportunity to be heard, if he wished, before making an award.—Id.

If a city was not harmed by a contractor's failure, after an award, to claim the right to a hearing before bringing suit, since, no proper award having been made because of the want of such hearing, the arbitrator may still act.—Id.

Power to Remove Official—Suit for Salary.

(Ga. App.) A municipal corporation has an incidental power to institute proceedings against, and remove from office for misconduct, all corporate officers, though the power to do so be not expressly given by the charter.—Burney v. City of Boston, 100 S. E. 28.

Where an officer summarily removed by the governing authorities of a municipal corporation admits that he refused to levy certain executions issued by the city, without showing that they were void, a finding is justified that the removal was for good cause, and the question of good faith on the part of the governing authorities is not in the case.—Id.

In instituting proceedings for the removal of a municipal officer for misconduct, the governing authorities of the municipal corporation may act either judicially or ministerially.—Id.

Where governing authorities of a municipal corporation act judicially in removing an officer, if there be an ordinance prescribing the form of procedure, the terms thereof must be adhered to and followed.—Id.

Where a municipal official is the incumbent of an office established by law with a prescribed tenure, and is not merely an appointee holding at the pleasure of governing power, in order that the act of a motion may have the effect of a judgment, notice must first have been given the delinquent official of the grounds for his removal and opporunity for a hearing granted.—Id.

A municipal officer who has been summarily suspended or discharged by the governing authorities acting ministerially may bring suit against a municipality for his wages or salary without first having been reinstated.—Id.

Where a municipal official has been summarily removed by the governing powers acting ministerially upon suit by him for the emoluments of his office, th emunicipality may defend by setting up and proving either the existence of any ground justifying the act of a motion, or that the action of the governing authorities was taken in good faith, and that the salary has in the meantime been paid. —Id.

NEWS OF THE SOCIETIES

Feb. 9-13.—AMERICAN ROAD BUILDERS' ASSOCIATION. Annual convention, Louisville, Ky. Secretary, E. L. Powers, 150 Nassau street, New York.

Feb. 11.—NEW ENGLAND WATER WORKS ASSOCIATION. Monthly meeting at Boston, Mass. Secretary, Frank J. Gifford, Dedham, Mass.

Feb. 16-18.—INTERNATIONAL CITIES AND TOWN PLANNING ASSOCIATION. Annual meeting, London, England. Honorary secretary, C. B. Purdon, 3 Grays Inn Place, London, W. C., England.

Feb. 20-21.—AMERICAN CONCRETE PIPE ASSOCIATION. Annual meeting, Chicago, Ill. Secretary, G. E. Warren, 210 South LaSalle street, Chicago, Ill.

Feb. 25.—NEW JERSEY SEWAGE WORKS ASSOCIATION. Annual meeting, Trenton, N. J. Secretary-treasurer, Frederick T. Parker, Guarantee Trust Bldg., Atlantic City, N. J.

May 10-11.—AMERICAN ASSOCIATION OF ENGINEERS. Sixth annual convention, St. Louis, Mo. Secretary, C. E. Drayer, 63 East Adams Street, Chicago.

May 18-21.—NATIONAL ELECTRIC LIGHT ASSOCIATION. Annual convention, Pasadena, Cal. Acting secretary, S. A. Sewall, 29 West 39th street, New York City.

June 21-25.—AMERICAN WATER WORKS ASSOCIATION. Annual meeting, Montreal, Canada. Secretary, John M. Diven, 153 West 71st street, New York City.

Oct. 4-8.—AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS. Annual convention, St. Louis, Mo. Secretary, Charles Carroll Brown, 404 Lincoln avenue, Valparaiso, Ind.

American Association of State Highway Officials.

The fifth annual meeting of the American Association of State Highway Officials was held Dec. 8 to 11 in Louisville, Ky., more than two hundred delegates being present.

A. R. Hirst delivered the presidential address in which he pointed out the tremendous task confronting highway builders next year and outlined some of the main problems to be worked out. The need of trained engineering help to make surveys, plans and preliminary investigations and to perform inspection; the threatened shortage of materials and shipping facilities; the regulation of prices; the development of efficient construction organizations; the need of improving location and alignment—all these were discussed in the address.

Among the other subjects discussed were: A system of records of the cost of all construction and of accounting for all funds available; publicity of plans and results not only in the local press, but in the national press; care of traffic during reconstruction; touring maps for the information of the people of the state and of other states; marking of the main traveled roads, keyed to the state maps; accommodations for the traveling public in the way of garages, hotels, public parking places and comfort stations; complete knowledge and study of, and, if necessary, the design of labor and time saving devices and equipment; a study of plant layouts and equipment for various types of construction under varying conditions; a study of the grade crossing situation and a strong campaign for improved conditions; the holding of road schools and short courses for the instruction and inspiration of all classes engaged in supervising and constructing highways; helping to formulate and pass adequate highway legislation so that the states may keep pace with each other.

After the president's address the remainder of the morning session was devoted to a survey of the national situation. A speaker representing each section of the country summarized briefly conditions in the group of states in his section under the following heads: (1) Approximate mileage and expenditures for construction in 1919; (2) Conditions as to prices and supply of labor and materials in 1919; (3) Actual new or proposed new state legislation of especial interest; (4) state or county bond issues past or pending; (5) proposed mileage of construction and probable expenditures in 1920; (6) anticipated conditions as to prices and supply of labor and materials in 1920.

On Monday afternoon Professor Arthur H. Blanchard, of the University of Michigan, spoke of the necessity for proper co-operation between adjoining states in order to keep down the cost of materials and construction.

C. M. Babcock, Minnesota, led the discussion on methods of administration. He emphasized that organization is a means to an end, not an end in itself.

A. N. Johnson, Chicago, chairman of the Committee on Salaries of Engineers in Public Service, of the American Association of Engineers, presented the schedule of salaries proposed by the association for highway engineering service. All who discussed the schedule agreed that salaries should be improved in order that good work may be accomplished.

On Monday evening representatives of the Associated General Contractors of America discussed relations between state departments and the contractors and presented suggestions regarding the possibilities of contractors with large organizations taking up highway work.

A resolutions committee was appointed as follows: Charles M. Upham, Delaware; Herbert Nunn, Oregon; W. O. Hotchkiss, Wisconsin; W. F. Cocke, Virginia; George E. Johnson, Nebraska. The following nomination committee was appointed: W. D. Uhler, Pennsylvania; C. M. Babcock, Minnesota; Chas. A. Browne, Florida; T. J. Ehrhart, Colorado; N. D. Darlington, California.

On Tuesday morning the problems of surveys, plans and designing were discussed. In the afternoon Clifford Older, chief highway engineer of Illinois, spoke on the design of highway bridges. Watson G. Clark, New Jersey, and F. E. Elliott, New Hampshire, spoke on the development of local sources of highway materials. H. S. Mattimore, Pennsylvania, discussed the relations between engineers and contractors, particularly the matters of prices, specifications, inspection and fair treatment.

Wednesday was mainly taken up with the subject of the distribution of Federal supplies and equipment and the relations of the various states with the Federal bureau.

On Thursday such subjects were discussed as contract bonds and a national program of highway research.

American Association of Engineers.

On January 2 the Chicago Chapter of the American Association of Engineers elected the following officers for the year 1920: W. J. H. Strong, president; W. H. Dean, 1st vice-president; A. M. Cornell, 2nd vice-president; C. L. Currier, 3rd vice-president; T. A. Dungan, 4th vice-president; J. D. Hoban, secretary; and L. D. Lea, treasurer.

The American Association of Engineers has appointed a committee on the salaries of engineers in teaching service, of which C. J. Tilden, professor of engineering mechanics at Yale University, is chairman. The other members of the sub-committee are being selected.

One of the means which will be employed by the American Association of Engineers to promote engineering publicity throughout the United States is through a co-operative arrangement with the producer of several moving picture weeklies. Arrangements have been made with the producers of six screen weeklies whereby the Association will furnish lists of engineering projects and works, photographs of which will interest the public. After the film people have been notified of some engineering structure or event of sufficient interest they will communicate with their corespondent living nearest the scene of the work or event and he will either take stills or 100 or so feet of film, as the situation merits.

In order to make this project successful the Association will require the active assistance of every professional engineer. Officials of corporations or construction companies who are doing or having done construction work or who are building or installing unusual or otherwise interesting types of machinery, engineers in charge of construction work or who are developing new methods, or who know of spectacular or otherwise interesting fea-

tures in which the public will be interested, can make this service a success by advising the "Profesional Engineer" or such projects as will warrant photographing.

Commercial engineering publications and society publications are requested to give this as wide a distribution among their readers as is possible in the interest of a greater publicity for the engineering profession. According to the association, "There has never been a time when the general public was so interested in mechanical and other engineering pictures. The time is propitious for developing in the mind of the American public a greater apreciation of the part which the engineer plays in society. An appreciation of the works of the engineer through photographs and moving pictures will not only supplement the publicity which is being obtained locally by the 100 chapters and clubs of the association, but will pave the way for a higher class of publicity which can be developed later."

The association asks of all engineers, "Do you know of any construction work, say of a large dam or bridge, or power plant or industrial works, or blast furnace, or cotton mill which would be of sufficient interest to attract the attention of the general public? Do you know of a new process which has appealing scientific features and which can be photographed readily? Do you know of any particular employment or welfare features employed by industrial engineers, managers or superintendents? Do you know of a survey which is to be attended by physical hardship or actual danger? Is there a building in your town which failed today because it was not designed or constructed under proper engineering supervision? Has your county or your state recently spent an enormous sum for highways? If it has, have the results been worthy of photographing? If you can answer any of these questions or any similar questions in the affirmative send a post-card or brief letter or telegram to the "Professional Engineer," advising the location of the work, and give a brief description of its purpose with the approximate cost or other particular features which make it worth photographing. If the location is out of the usual course of travel, tell how the photographer can reach the work. Your letter need not be long. Just outline the essentials as mentioned and you will be doing the profession a great service. Although the publicity committees of the chapters and clubs of the American Association of Engineers can be of great service in this matter, this appeal is not made wholly to the members of the American Associations of Engineers. Other engineers, public officials, corporation officials, and others who are acquainted with engineering features of interest to the public are earnestly requested to render whatever assistance they are able in this development of engineering publicity."

American Water Works Association.

The nominating committee of the American Water Works Association, met at Indianapolis, Ind., December 20, 1919.

The nominations of the committee are: for president, Beekman C. Little, Rochester, N. Y.; vice president, Edward Bartow, Urbana, Ill.; treasurer, J. Walter Ackerman, Auburn, N. Y.; trustees, 2nd district, Harry F. Huy, Buffalo, N. Y.; 5th district, Robert J. Harding, San Antonio, Texas.

District No. 2 consists of the state of New York. District No. 5 consists of District of Columbia, state of Maryland, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Missouri, Tennessee, Kentucky, Arkansas, Louisiana, Kansas, Oklahoma and Texas.

In accordance with the constitution (Article VI, Section 4) additional nominations for any office may be made "At any time prior to noon on the first day of March by request to the Secretary, signed by at least twenty-five Active, Honorary or Corporate members," the names so nominated to be put on the final ballot, following those nominated by the nominating committee in alphabetical order.

Petitions should be sent to the office of the secretary, J. M. Diven, 153 West 71st street, New York, N. Y.

American Road Builders' Convention Show.

The Seventeenth Convention and Show will open at 2.30 p. m., Monday, February 9th, at the Jefferson County Armory, Louisville, Ky. Governor Morrow of Kentucky will give the opening address of welcome.

Following the Governor's address, Mayor Geo. Weissinger Smith will welcome the delegates in behalf of the city. President G. P. Coleman will respond for the association.

Papers under the general head, "Design and Construction of Different Types of Pavements" will be presented on Tuesday, February 10th, at both the morning and afternoon sessions. The topics to be taken under consideration in the morning are "Concrete Pavements" and "Brick Pavements." In the afternoon papers on "Bituminous Macadam," "Bituminous Concrete" and "Surface Treated Macadam and Gravel" will be delivered. Following each paper will be discussions on the subject, in which all members of the Congress are invited to participate. Motion pictures showing various methods of road construction will be exhibited in the evening.

Both the morning and afternoon sessions of Wednesday, February 11, will be given to the presentation and discussion of papers and reports of committees.

The report of the Committee on "Method of Strengthening and Reconstructing Highway Bridges for Heavy Motor Traffic" will be given on Thursday morning, February 12, followed by the presentation of technical papers. A paper on "Factors which will limit Highway Construction During the Coming Season" and the report of the Committee on "Regulations Covering Speed, Weight and Dimensions of Motor Trucks" will be presented at the afternoon session. In the evening, motion pictures will be shown illustrating the various phases of road construction and maintenance.

Friday, February 13, will be devoted to the presentation of papers and reports dealing with technical problems in road building. Many leaders in road building circles will discuss problems which they have met in their experiences and tell how they overcame difficulties. Discussions will follow and this exchange of ideas will have great educational value.

Invitations have been sent by Governor Morrow to all the governors of the several states and Canadian provinces, and by Mayor Smith to all the mayors of the cities, requesting that delegates be sent to the convention. The number of replies received signify that the attendance of state and municipal officials will be unusually great and that this convention will be the largest of any yet held.

It is reported that the State Legislature is contemplating adjourning for a day to attend the convention in a body. At the headquarters of the association applications for space at the Good Roads Show held in conjunction with the convention indicated that the 50,000 square feet available for exhibition purposes will be inadequate. Manufacturers, it is said, are fully awake to the importance of this event and are showing great zeal in placing their goods before the men who will direct the expenditure of over a billion dollars in road work during the coming year.

The Association subscription dinner at the Hotel Seelbach, Monday evening, at 7 o'clock. Tickets, $4.00 each. Stag and absolutely informal; business suits only; no speech making; elaborate vaudeville entertainment furnished by the people of Louisville.

The Association reception and ball at the Hotel Seelbach at 9 o'clock Wednesday evening, strictly formal. This will be the big social event of the convention. Invitations obtainable at Convention Headquarters.

The good people of Louisville have planned a series of entertainments for the ladies. This will include a matinee, an automobile ride, a card party, a shopping tour, etc.

New Jersey State Association of County Engineers.

At the annual meeting of the N. J. State Association of County Engineers, held at the Engineers' Club at Trenton on Tuesday, January 20, 1920, the following papers were read: "A Method of Numbering Highway Bridges," by Harry F. Harris, County Engineer of Mercer County; "The Attitude of the Board of Commerce and Navigation on Reconstructing Bridges Over Navigable Streams," by J. J. Albertson, County Engineer of Camden County; "Needed Reforms in Highway Work," by James Logan, County Engineer of Burlington County.

The following officers were elected for the ensuing year: President, Thomas J. Wasser, County Engineer of Hudson County; vice-president, A. H. Nelson, County Engineer of Atlantic County; secretary, Harry F. Harris, County Engineer of Mercer County, and treasurer, Alvin B. Fox, County Engineer of Middlesex County.

National Electric Light Association.

President R. H. Ballard of the National Electric Light Association reports that Frank M. Kerr, vice-president and general manager of the Montana Power Co., has accepted the chairmanship of the Committee on Steam Railroad Electrification. The Montana Power Co., of which Mr. Kerr is the operating executive, is now furnishing the power supply for the operation of 657 miles of track of the Chicago, Milwaukee & St. Paul Railroad in Montana and the Pacific Northwest, and consequently Mr. Kerr is in a position to speak with authority on

the subject of railroad electrification from a practical standpoint. R. Beeuwkes, electrical engineer of the Chicago, Milwaukee & St. Paul Railroad, will act with Mr. Kerr on this committee, and the additional members will be from other power companies, manufacturers and banking institutions, so that every phase of this great subject will be intelligently handled in the report of the committee which will be submitted at the Pasadena, Cal., convention, May 18 to 21.

M. S. Sloan, president of the Brooklyn Edison Co., Brooklyn, N. Y., has accepted the appointment by President Ballard as chairman of the Committee on Electrical Resources of the Nation. Mr. Sloan is organizing a committee to handle this great subject representative of all branches of the industry. The committee's report to be represented at the next annual convention will be in the nature of a textbook of particular assistance to the small companies throughout the country. The present status of electrical development in the United States, both private and municipal, will be noted, and the comparisons, drawn between different sections of the country and between private and municipal operation, should prove to be very interesting.

Advertising for the Engineer.

Wm. J. H. Strong, president of the Chicago Chapter of the American Association of Engineers, delivered an address at the annual dinner of the Indiana Engineering Society on Friday evening, January 23, in Indianapolis. The subject of his talk was "Advertising for the Engineer."

PERSONAL.

Kelly, John R., has become mayor of Muncie, Ind., succeeding Rollin H. Bunch.

Grace, John P., was recently elected mayor of Charleston, S. C.

Miller, Winton L., has resigned his position as city manager of Bethlehem, Pa. He was formerly secretary to city manager Waite, of Dayton, and later city manager of St. Augustine, Fla.

Wilder, Henry L., who has been superintendent of state highways in Lebanon county, Pennsylvania, since 1912, has received notice of his promotion to the office of township engineer, district No. 10, of the bureau of township highways. Mr. Wilder in his new work has charge of highways in the counties of Lebanon, Schuylkill, Northampton, Carbon, Berks and Lehigh, in as far as state money is used in construction of township or county roads and highways.

PROBLEMS CITIES ARE STUDYING
WITH EXPERTS

Batesville, Ark., is having plans prepared by the consulting engineering firm, W. R. Heagler & Sons, for PAVING IMPROVEMENTS on about nine miles of street.

A new WATER WORKS SYSTEM is to be built by the city of Paragould, Ark., plans for which are being prepared by the consulting engineering firm, W. R. Heagler & Sons, who will also supervise the construction.

PAVING IMPROVEMENTS are to be made by the city of Hartshorne, Okla., preliminary plans for which are being prepared by the consulting engineers, the V. V. Long Engineering Co.

Moweaqua, Ill., is planning SEWERAGE IMPROVEMENTS involving a disposal plant and sewerage system. Preliminary plans are being prepared by the consulting engineers, Miller, Holbrook & Warren.

East Hartford, Conn., has advertised for bids for extensive WATER WORKS IMPROVEMENTS, including two covered concrete reservoirs, a low dam, pipe line, etc. The consulting engineer is James H. Fuertes.

Kenosha, Wis., has advertised for bids for the construction of a reinforced concrete bascule BRIDGE over the harbor. The consulting engineers are the Strauss Bascule Bridge Co.

Goldsboro, N. C., has advertised for bids for STREET PAVING IMPROVEMENTS, covering about 100,000 square yards of pavement, 55,000 lineal feet combined concrete curb and gutter 5,000 square yards of sidewalk paving, etc. The consulting engineer is J. L Ludlow.

Girard, Kans., is to improve WATERWORKS SYSTEM to cost about 44,000, according to plans prepared by the consulting engineers, W. B. Rollins & Co.

The city of Enid, Okla., is soon to let contract for WATER WORKS IMPROVEMENTS, involving 100,000 feet of cast iron pipe, etc. The consulting engineers are Black & Veatch.

Altus, Okla., voted $45,000 bonds for WATER WORKS IMPROVEMENTS. The consulting engineers are Johnson & Benham.

PAVING IMPROVEMENTS are to be made by the city of Ada, Okla., to cost $350,000, involving 65 blocks. Plans are being prepared by the consulting engineers, Johnson & Benham.

Collinsville, Okla., is having plans prepared by the consulting engineers, Johnson & Benham, for PAVING IMPROVEMENTS, involving twenty-five blocks of brick or concrete pavement, to cost $125,000.

Nowata, Okla., will soon let contract for PAVING IMPROVEMENTS in various strets, according to plans prepared by the consulting engineers, Archer & Stevens.

Canton, O., has retained R. Winthrop Pratt, consulting engineer, to prepare plans and supervise the construction of a WATER IMPROVEMENT project to cost $1,280,000.

Hill County, Hillsboro, Tex., is to spend $2,500,00 on ROAD IMPROVEMENTS. The consulting engineers are Bryant & Huffman.

A hydro-electric commission has been appointed in South Dakota under an act of the legislature, for the purpose of investigating the WATER-POWER RESOURCES of the Missouri River in that state. This commission has engaged Daniel W. Mead and Charles V. Seastone, consulting engineers, to investigate and report.

WATER WORKS IMPROVEMENTS, including water purification plant, pumping station and transmission line, will be made by the city of Pryor Creek, Okla., acording to plans prepared by the consulting engineers, V. V. Long & Co.

Marlow, Okla., is having final plans prepared by the consulting engineers, V. V. Long & Co., for PAVING IMPROVEMENTS.

ROAD IMPROVEMENTS are to be made by the city of Bartlesville, Okla., for which the state highway commissioner will call for bids later. The consulting engineers are Elston & Witten.

Comanche, Okla., is to make PAVING IMPROVEMENTS, involving twenty blocks, for which plans are under way. The consulting engineers are H. G. Olmsted & Co.

Lake Benton, Minn., will make SEWERAGE IMPROVEMENTS, involving 12 to 42-inch storm sewers in various streets, to cost $75,000. Plans are being prepared by the Bradley Engineering Service.

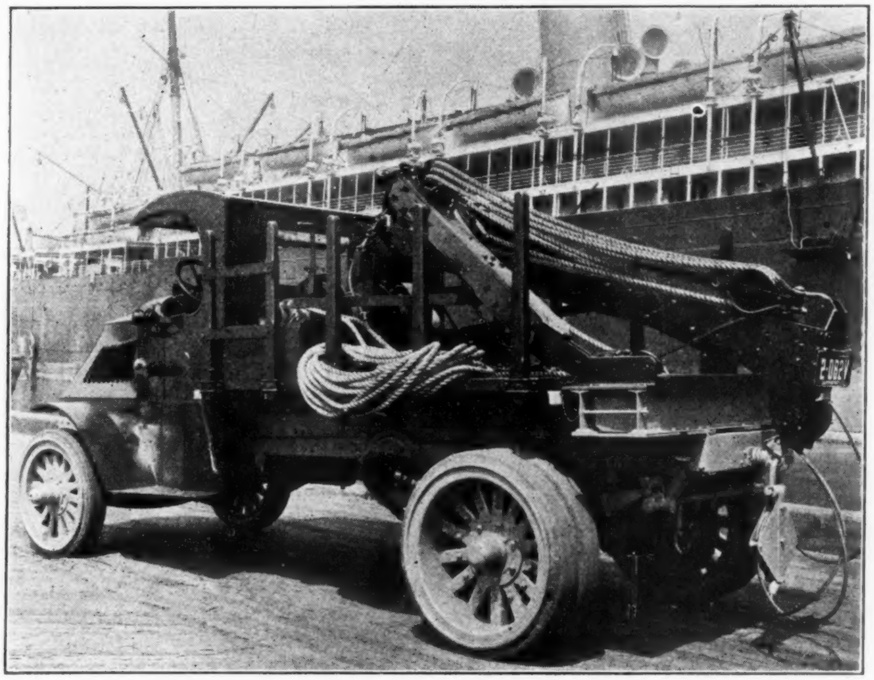
Madelia, Minn., will make PAVING IMPROVEMENTS to cost $100,000, according to plans being prepared by the consulting engineers, the Bradley Engineering Service.

Winnipeg, Manitoba, contemplates $1,000,000 of provincial government DRAINAGE CONSTRUCTION WORK. J. G. Sullivan, MacIntyre building, engineer.

Twin Falls, Idaho, plans the erection of a SUSPENSION OR CANTILEVER BRIDGE across Snake river, canyon at Shoshone Falls, to cost about $350,000. Mr. Murray, engineer.

NEW APPLIANCES

Describing New Machinery, Apparatus, Materials and Methods and Recent Interesting Installations.



WRECKING TRUCK WITH DERRICK FRAME RIGGED WITH HOIST TACKLE AND LOWERED FOR TRANSPORTATION.

Mack Wrecking Truck

A Mack 7½-ton service wrecker similar to the ones used by the fire departments in New York, Boston, Cleveland, Baltimore and other large cities, has been delivered to the West India Oil Company, Havana, Cuba. It is equipped with a Meade-Morrison horizontal drum winch and collapsible derrick. The derrick is removable and the truck body may be used to haul merchandise.

In use, the derrick extends back over the rear of the truck, is capable of lifting the heaviest trucks bodily from the ground, and can tow disabled trucks on either front or rear wheels by raising the other end clear of the ground. Under the rear of the body platform are two I-beams to support the weight of the derrick. Between the I-beams are two heavy 8 by 10-inch wood blocks, which, when the derrick is in use, rest on the ground and thus relieve the springs.

Motor Plows Remove Snow in Chicago

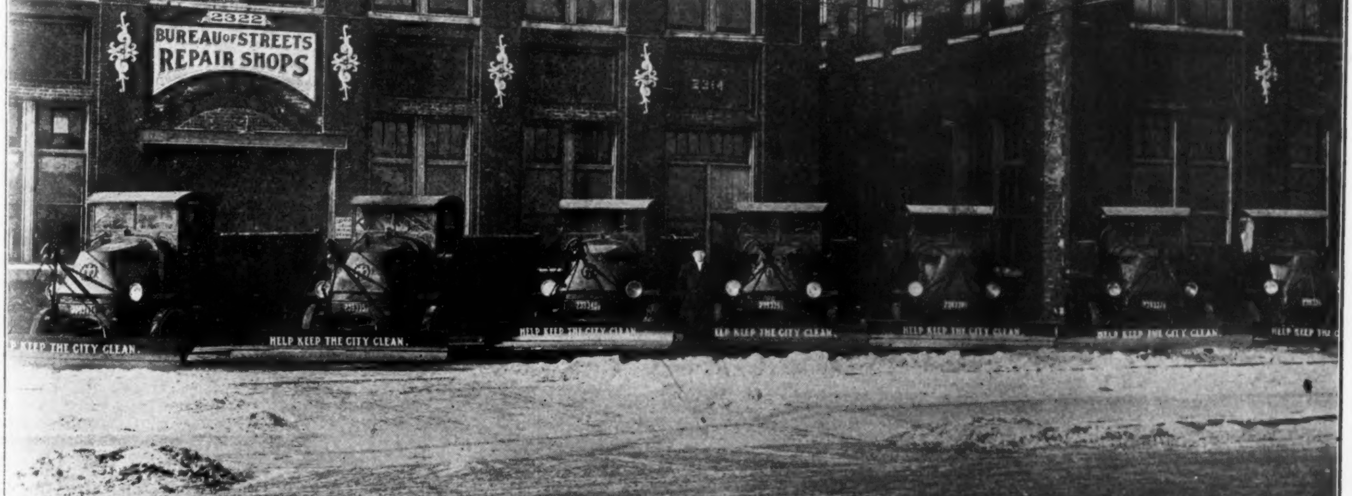
Here is a fleet of seven Mack motor snow plows operated by the Bureau of Streets in Chicago. Their speed adapts them for removing the snow while it is falling. The plows are demountably attached to the trucks which have dump bodies that can be utilized the year round. On each plowshare is inscribed "Help Keep the City Clean."

The judicious use of economical, efficient automobile snow plows wherever city streets are obstructed by heavy snow fall will be a substantial help to the fuller utilization of the expensive highways for continuous service.

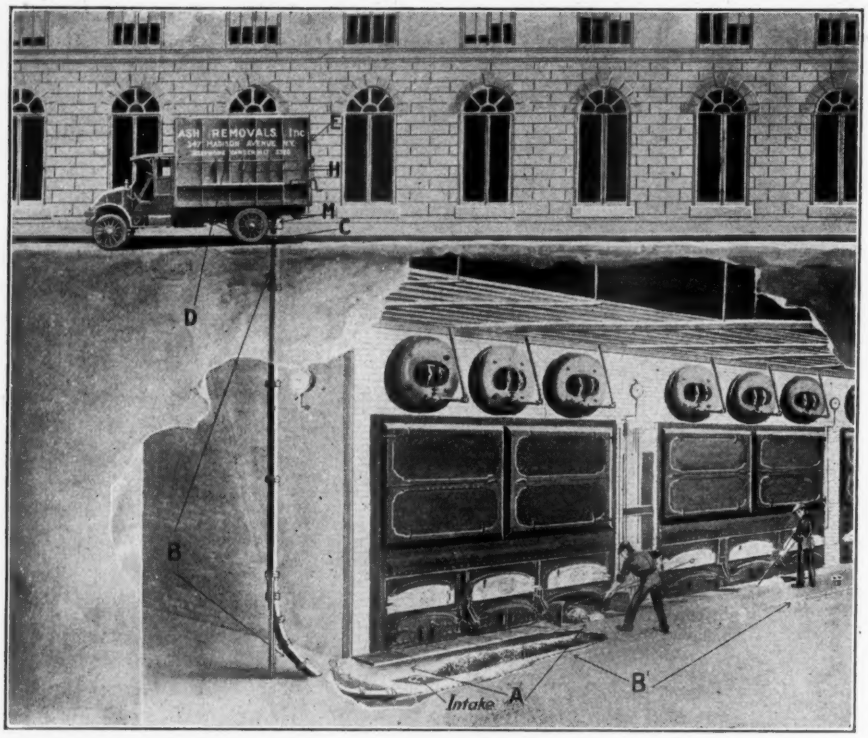
Pneumatic Ash Conveyor

A new method for the economical and sanitary removal of ashes from basement and cellar boilers, by pneumatic operations, to a movable hoisting plant in the street, discharges them without producing any nuisance, to dump carts which convey them to the points of disposal. This system allows the hoisting apparatus to remain in continuous operation at one point or to be moved independently from point to point as served by one or more dump trucks with a minimum of delay and labor.

The ashes are raked as usual from under the boilers into a 3x3-foot concrete ash pit A, extending across the face of the boilers and covered with removable sectional floor plates. In the bottom of the ash pit there are located intakes into the 8-inch pneumatic pipe B-B′ that is carried up to a point just below the sidewalk, where



CHICAGO MUNICIPAL MOTOR TRUCKS EQUIPPED WITH DEMOUNTABLE SNOW PLOWS.



PNEUMATIC ASH HOIST AND CONVEYOR INSTALLED IN BASEMENT.

it can be attached by a flexible connection M, to the conveyor truck D, which is provided with a high-pressure blower driven by the truck motor, a washing device for removing dust before the ashes are discharged, a silencer, and a steel bin or separator E, which latter forms the body of the truck.

In operation the ashes are allowed to accumulate as long as desired and when the conveyor truck arrives and is connected to the pneumatic pipe below the sidewalk, an assistant in the boiler room attends to the feeding in the ash box while the operator controls the machinery and the ashes and foreign materials which may be mixed with them are hoisted, dampened and discharged to the dump truck through gates M, operated by a rack and pinion driven by a hand crank shaft.

The apparatus up to the sidewalk level, is sold outright, guaranteed, and for a small annual sum is maintained for 10 years and the ashes are removed by the owners of the conveyor and trucks at a fixed rate per cubic yard based on a percentage of ash resulting from a given quantity of coal consumed, as shown by the coal bill or boiler room log.

The present charge for ash removal in New York City is 90 cents per cubic yard, equivalent to about 7½ cents per can. Typical installations can be seen at the Palace Theatre, Hotel Lorraine, the Garford Building and other places in New York City.

The advantages claimed are low cost of installation of the apparatus, saving in labor, boiler room space, elevator installation and maintenance, and the elimination of dust, dirt, noise, fire risk, and dangerous sidewalk openings. It is also noted that at an estimated cost of $6.00 each, and an average life of 6 months, the expense of 3⅓ cents per cubic yard for ordinary ash cans is eliminated. The manufacturers of this apparatus state that the cost of removal of ashes in New York City by the other methods ordinarily employed will run as high as 7½ cents per can.

INDUSTRIAL NEWS

Waterworks Equipment Needed in Trinidad Towns.

According to advices from Consul Henry D. Baker, Trinidad, British West Indies, the mayor of Port of Spain, the capital and largest town of Trinidad, in his annual report to the town council, mentions that it is desirable to install more powerful pumps and build a reservoir holding 4,000,000 gallons, the water to be distributed through the city by gravitation after filtration. He also mentioned that plans had already been prepared by the city engineer for additional water supply for the eastern part of Port of Spain, which include the following features, at an estimated cost of $14,000:

(1) A circular reservoir to deal with water supply of the East Dry or Laventille River, to be constructed of reinforced concrete, 50 feet in diameter and 10 feet in effective depth, containing 120,000 gallons (about two days' supply for the entire district), to be erected on a site near the eastern boundary of the city on land selected by the city engineer.

(2) A four-stage centrifugal pump capable of delivering 10,000 gallons per hour against a head of 200 feet, to be driven by a 25-horsepower electric motor, the pump to be placed on the lands of the present Laventille Reservoir, from which the water to fill the new reservoir will be taken.

(3) A pumping main, about 3,000 feet in length, connected with the new pumping plant as well as with the existing 12-inch main feeding the Laventille Reservoir.

The town council has appropriated the $14,000 necessary for the East Dry River increase of water supply. Correspondence of any American manufacturers who might be interested should be addressed direct to the City Engineer, Port of Spain, Trinidad, British West Indies.

The Legislative Council of Trinidad has appropriated the amount of $83,769 for additional waterworks and improvements to existing waterworks for the towns of St. Joseph and Tunapuna, about 8 to 10 miles from the municipality of Port of Spain; and also the amount of $40,000 for waterworks, supplying water from the Arima River, for the town of Arima, about 20 miles from Port of Spain. Correspondence of American manufacturers who might be interested should be in English with the Director of Public Works, Trinidad Government, Port of Spain, Trinidad.

The Blaw-Knox Company.

A. A. Olstad, formerly connected with the New York office, has been made manager of the New England territory, with offices in the Little Bldg., Boston, Massachusetts, succeeding A. W. Ransome, who has been appointed manager of the Pacific Coast territory, with offices in the Monadnock Building at San Francisco.

A. W. Ransome, formerly manager of the New England territory, with offices at Boston, Massachusetts, has been transferred to San Francisco in the capacity of manager of the Pacific Coast territory with offices in the Monadnock Building, San Francisco.

Mr. Ransome was born in San Francisco, and is a graduate of the University of California, Class of 1897. He played fullback on the university eleven for four years, captaining the team of 1896. Immediately after leaving college, Mr. Ransome became engaged in construction work and in the construction machinery business until 1917 when he became associated with the Blaw-Knox Company.

Westinghouse Man Gets Promotion.

An announcement is made by the Westinghouse Electric & Manufacturing Company that R. A. Neal has been appointed as manager of their switch section, succeeding F. A. McDowell, now manager of the newly created cost and development section.

Mr. Neal came to the Westinghouse company shortly after his graduation from New Hampshire State College, in 1910, and has served in the various capacities of order man, inquiry man and assistant manager of the switchboard section.